REGD. NO. M. 2799

Current Science

Vol. 26, No. 3 MARCH 1957 Pages 69-100

Current Science

Vol. XXVI] MARCH 1957 [No. 3

INTERACTION OF PHYSICAL AND BIOLOGICAL SCIENCES*

At one time the segregation of the physical and the biological sciences could scarcely have been more complete. But the lines of demarcation are gradually vanishing, and a fusion between the two is occurring in many places, *e.g.*, the interpretations of nerve action in terms of ionic flow, and of cortical events in terms of spatio-temporal patterns of neuronal activity; the analogies between the working of the brain and the operations of electronic calculators; all these and many more have for a long time compelled the simultaneous study of widely different fields of science.

The relation of molecular structure to properties is a major chapter of science and now forms a body of doctrine built up over a century. Through the stimulus, partly industrial, of the intensive work on polymers—those huge molecules now made almost to a predetermined specification of properties—this study to-day embraces some of the chief constituents of the living cell.

Natural compounds of very high molecular weight, formed at low temperature and under the directing influence of existing cell structures, have normally a much more regular configuration than the chains randomly formed in polymerizations initiated by free radicals at high temperatures. The gap between the natural and the artificial has been significantly narrowed by the recent discoveries of Ziegler and of Natta. By the use of new catalysts based upon aluminium alkyls and titanium or vanadium chlorides, beautifully oriented polymers of regularly repeating structures are formed. The initiation mechanisms may well be ionic, and the regularity is almost certainly due to the guiding influence of a heterogeneous catalyst.

* Excerpts from the Presidential Address to the Royal Society entitled "Some Interactions of the Physical and the Biological Sciences," delivered by Prof. C. N. Hinshelwood.

The closer approach of this mechanism to that used in the cell is very suggestive. Substances closely resembling natural rubber and guttapercha (which stand in a *cis-trans* relation to one another) have indeed been made by such means. The properties of these regularly ordered polymers are profoundly different from those of the less ordered forms, and during 1956, Natta, Corradini and Dall'Asta, in a study of crystalline polypropylene oxide, have commented on the notable analogies between their product and the fibroin of silk.

In this general connexion, the recent work of Ballard and Bamford is highly suggestive. These authors find that in the polymerization of DL-phenyl-alanine-N-carboxy α-amino-acid anhydride initiated by polysacrosine dimethylamide, the polysarcosine chain is able to catalyse the reaction between the base and the anhydride in a marked degree. They justly point out the analogy between this phenomenon and an enzyme reaction.

Work continues in many laboratories on the fibrous and globular proteins and on nucleic acids (and models have recently been shown to the Royal Society of the beautiful structures which the X-ray crystallographers are beginning to propose for these vitally important substances).

The problem is enormously complicated, but its attraction depends, of course, largely upon the belief, widely held on good grounds, that these structures are fundamentally concerned in the processes of heredity. Nevertheless, the view that nucleoproteins are the basis of genes which could be self-replicating in isolation and merely in virtue of their structure is probably a dangerous over-simplification.

In the chemistry of inanimate Nature the study of structure alone is quite insufficient and must be undertaken in conjunction with that of function; in other words, reaction mechanisms are as important as molecular structures.

That the properties of living things are an emergent result of contributions from finite, if large, numbers of structural units of genes, that the genes are rather stable though not immutable, that in proper circumstances they change their associations in accordance with the laws of probability, are among the major basic principles of science. Recent work has, however, widened the view of the ways in which hereditary characters are transmitted. Besides sexual unions there are transmission by infective agents, by transduction and by Pontecorvo's parasexual mechanisms. Moreover, the combinatory phenomena that are so important in the Mendelian system cannot play much part in micro-organisms which multiply by binary fission. Fruitful as the reference of cell properties to the structure of genes has been, the body of doctrine which rests on this assumption is in some important respects incomplete, as indeed every chapter of science must be incomplete by itself. The picture presented is essentially static. The phenomena of growth, adaptation and reproduction need a dynamic one.

No one structure is likely to be autosynthetic in isolation; even the viruses require as host more or less intact cells, the machinery of which they can exploit. The building blocks of the cell, wonderful though they may be as structures, are useless by themselves. Cell function depends upon the rhythm and harmony of their reciprocal actions: the mutual dependence of protein and nucleic acid; the spatial and temporal relations of a host of elementary processes which with their sequences and bifurcations make up the reaction pattern of the cell. A system of mutually dependent parts each of which performs something like enzymatic functions in relation to another, will, as can easily be shown, in the steady state appear as a whole to be autosynthetic. No individual part need be credited with a new and mysterious virtue by which to duplicate itself. Thus the picture widens beyond the structural units to their quantitative proportions, to their reciprocal dependence and to their rate of growth. This fusion of physical chemistry and biology leads to conclusions about the nature of adaptive processes, the automatic attainment of maximum growth-rates, and mechanisms for the choice of the most favourable metabolic patterns (as in the Pasteur effect).

The reality of the dynamic picture is sometimes called in question because there may be alternative explanations of particular phenomena. For example, the important phenomenon whereby drug resistance develops is often referred exclusively to selection of random mutants, although it is easy to show on the basis of very general physico-chemical assumptions that the effect should demonstrably occur as an automatic response, the adapted cells having reorganised their reaction patterns. This conclusion in its turn in no way denies the possibility of spontaneous resistance due to structural mutations. Nor, on the other hand, does the occasional demonstration of mutations leading to resistance rule out automatic cytoplasmic adjustments.

Normally, mutations, apart from those caused by radiation or special chemical agents, have been supposed to occur only when cells divide. This view itself seems to be changing. Some years ago, Baskett made a number of observations individually and collectively indicating that during the long delay which attends the first growth of *Bact. lactis ærogenes* on D-arbinose, there is in fact a physiological adaptation of the cytoplasm, and not the selection of mutants. Generally similar results have been found by Dean for cells initially reluctant to use lactose.

Somewhat analogous observations in a more spectacular form were reported by Akiba, and more fully by Szybalski. Bacterial strains exposed to streptomycin for a number of days in a buffer not supporting growth were found eventually, if they had survived at all, to have become resistant to the antibiotic. Szybalski, however, quotes what he calls "tentative evidence" that the changes occur in a nucleus. The conclusion, however, seems to be far from certain, since the relations found in crossing drug-resistant with sensitive organisms are usually very complex. In genetic analysis with micro-organisms the number of parameters which can be adjusted is considerable, and illusory effects of sharp segregation phenomena are sometimes produced by the process of dividing continuous variables such as rate or time of growth into arbitrary domains such as 'slow' and 'fast' or '*plus*' and '*minus*'. That a high percentage of non-dividing cells should suffer nuclear mutations making them resistant precisely to that drug to which they are being exposed seems much harder to explain than the alternative of a dynamical change by which the cell as a whole reacts to the presence of the drug in an almost predictable way. The same general comments might be made about the 'spontaneous mutations' in the absence of division, to histidine-independence of a bacterial strain recently studied by Ryan.

In spite of some alarm, physico-chemical mechanisms of cell adjustment need not be in any conflict at all with valid principles of genetics. But it is a misapplication of the latter when they are used to exclude all mechanisms except selection of random mutants or of favourable gene combinations. Random mutations to drug resistance may indeed be shown by the relatively rare examples where the Lederberg technique of replica plating has given positive results. Nature, however, presents us with a vast hierarchy of systems: sub-atomic units (in a vast and confusing array), atoms and molecules, micelles, chromosomes, nuclei, cells, colonies, tissues, individuals and communities of individuals. Nobody can suppose that all phenomena have their origin at any one particular level.

The disentangling of the complicated and fascianting relationships met with in this field will demand close co-operation of the physical and biological sciences, which in other words, only means that to the highly ingenious models of structure must be added equally illuminating models of function. Whatever the answer may be to the controversial problems of today, that is what the future in one way or another will surely bring forth.

DARWIN CENTENNIAL EXPEDITION

THE Darwin Anniversary Committee, Inc., has announced that Charles Darwin's historic round-the-world trip, which helped him formulate his theory of evolution, will be retraced in 1958. The year 1958 was chosen because it will be the centennial of Darwin's presentation of his paper to the Linnæan Society in London outlining his theory of evolution. Julian S. Huxley, the biologist, is Honorary Co-Chairman of the Planning Committee. Lady Nora Barlow, a descendant of Darwin, is the other Co-Chairman.

Darwin sailed in the British ship *Beagle* as official naturalist on a surveying trip. The expedition, which took place between 1831 and 1836, visited islands in the Atlantic, the coast of South America and adjacent islands, and islands of the western Pacific. The Darwin Committee plans to cover the same areas in a year's time, using a 100- to 150-foot sailing ship with auxiliary engines.

On his trip Darwin studied native people and the flora and fauna of the areas. The modern voyage will compare ecologic conditions to-day with those of 125 years ago. The 1958 trip also will seek to determine, if any, species of flora and fauna are in danger of becoming extinct. In the next few months about 20 scientists, both men and women, will be selected as Darwin fellows to sail on the expedition. Others probably will be flown to the research areas.

THE ROLE OF PANTOTHENIC ACID IN THE BIOSYNTHESIS OF ASCORBIC ACID IN THE RAT

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THE role of the vitamins of the 'B' group, in general, in the biosynthesis of ascorbic acid in the rat has been investigated by several workers. Thus Svirbely[1] found in 1936 that adequate amounts of vitamin 'B' factors are essential to obtain normal values for vitamin C in the organs of the rat. Guha and co-workers[2-4] have found that adequate thiamine, riboflavin, pantothenic acid and folic acid nutrition is a prerequisite to chloretone stimulation of ascorbic acid synthesis in the rat.

The work of Isherwood *et al.*[5] has shown that ascorbic acid is synthesised in the rat by the following pathway: D-Glucose → D-Glucuronic acid → L-Gulonic acid → L-ascorbic acid. King and his co-workers[6-8] have confirmed that glucose and glucuronic acid are precursors for the synthesis of ascorbic acid in the rat by tracer technique.

Sastry and Sarma[9] have found that thiamine is required for the conversion of glucuronic acid to ascorbic acid in the rat. Nath *et al.*[10] have shown that a condensation product of glucose and ethyl acetoacetate, glucose cyclo-acetoacetate, brings about an increased synthesis of ascorbic acid in germinating mung beans and also in rats. This was confirmed in our laboratory by radioactive tracer technique.[11] Further, it was shown that thiamine and pantothenic acid were required for the conversion of glucose cyclo-acetoacetate to ascorbic acid in germinating greengram.[11]

In the present investigation the role of pantothenic acid in the conversion of the precursors glucose cyclo-acetoacetate and glucuronic acid to ascorbic acid has been studied. Also, in view of the fact that D-glucuronolactone was found to be an intermediate in the conversion of D-glucose to L-ascorbic acid,[5-8] the effect of glucose-cyclo-acetoacetate on the urinary excretion of glucuronic acid has been studied.

Methods.—Pantothenic acid deficiency was produced in rats in the following manner: Ten weanling male albino rats, divided into two groups of five each, were housed in individual cages and fed control and pantothenic acid-deficient diets, recommended by Olson and Kaplan[12] for 8 weeks. After 6 weeks, when the rats kept on the deficient diet did not gain weight they were put in individual metabolism cages and were given the same diet as before. Urine collections were made for 48 hours in beakers containing 5 ml. of 10% oxalic acid solution and a little toluene. Ascorbic acid in the urine samples was estimated by the method of Roe and Kuether.[13] The rats were then given glucose-cyclo-acetoacetate (25 mg.) or D-glucuronolactone (100 mg.) as the case may be, by intra-peritoneal injection of their aqueous solutions. The urinary excretion of ascorbic acid during the next 48 hours was determined in each case.

It was found desirable to estimate glucose-cyclo-acetoacetate in urine in order to see whether in pantothenic acid deficiency, this compound got accumulated. For this purpose, a highly sensitive spectrophotometric method was used. A solution of glucose-cyclo-acetoacetate in methanol was found to show maximum absorption at 250 mμ using Beckmann model DU quartz spectrophotometer.

Before estimating glucose-cyclo-acetoacetate in the urine samples, a preliminary purification of the samples was carried out, to eliminate interfering substances, in the following manner: The urine samples were repeatedly extracted with ethyl ether. The ether was evaporated and the residue was dissovled in 0·5 ml. of ethanol. The whole of this solution was applied as one spot on Whatman No. 1 filter-paper, along with a few spots containing pure glucose-cyclo-acetoacetate. The spots were subjected to ascending paper chromatography using the solvent mixture *n*-butanol, methanol, benzene and water in the ratio 2 : 1 : 1 : 1 as the mobile phase. The paper was then cut into vertical strips and the strips containing pure glucose-cyclo-acetoacetate were sprayed with 0·05% potassium permanganate solution. The spots were located by immediate decolourisation. The mean R_f value was determined and was found to be 0·83. From the strips containing the test samples, the regions corresponding to the R_f of the pure compound were cut off and eluted with methanol. The eluates were suitably diluted with methanol and their optical densities read out at 250 mμ.

Glucuronic acid excreted in the urine before and after an intraperitoneal injection of glucose-cyclo-acetoacetate was estimated by the method of Dische.[14] Normal rats, about 100 g. in weight, were used in this experiment.

Results and Discussion.—From Table I it may be seen that the normal excretion of ascorbic

cid was very much lowered in pantothenic cid deficiency. Also, whereas in the control ats the excretion of ascorbic acid increased fter an injection of glucose-cyclo-acetoacetate, here was no such increase in the case of defi-ient rats, thereby showing a requirement of antothenic acid for the conversion of glucose-yclo-acetoacetate to ascorbic acid. Injection

TABLE I

Influence of pantothenic acid deficiency on (a) the synthesis of ascorbic acid in rat, from (1) glucose-cyclo-acetoacetate, and (2) D-glucuronolactone, (b) the metabolism of glucose-cyclo-acetoacetate

Rat group	Average urinary excretion of ascorbic acid (mg. per rat per day)					Average urinary excretion of glucose-cyclo-acetoacetate after an injection of 25 mg of the compound (mg. per rat per day)
	Before injection	After injection of glucose-cyclo-acetoacetate	Mean increase	After injection of glucurone	Mean increase	
Control	0·59	0·91	0·32	1·12	0·53	0·39
Deficient	0·34	0·38	0·04	0·88	0·54	1·023

TABLE II

Effect of an intraperitoneal injection of 25 mg. of glucose-cyclo-acetoacetate into rat on urinary excretion of glucuronic acid

Rat No.	Weight of the rat (gm.)	Amount of glucuronic acid excreted (mg. per rat per day)	
		Before injection	After injection
1	140	6·0	9·6
2	110	3·6	5·0
3	100	3·1	4·7
4	80	3·9	6·1

f D-glucurono lactone brought about an ncrease in ascorbic acid excretion both in con-rol and in deficient rats, showing that panto-henic acid is not needed for the conversion of -glucuronic acid to ascorbic acid.

It may also be seen from the results pre-ented in Table I that out of the injected amount of glucose-cyclo-acetoacetate, there was greater excretion of unmetabolised compound by the deficient rats than by the control rats indicating the need for pantothenic acid in the metabolism of glucose-cyclo-acetoacetate. It may further be pointed out that in both the groups, most of the injected compound was metabolised in the body of the rat.

The data in Table II shows that injection of glucose-cyclo-acetoacetate into rats brought about a significant increase in the urinary excretion of glucuronic acid. It has been shown earlier by other investigators that an increase in the urinary excretion of ascorbic acid is usually accompanied by an increase in the urinary excretion of glucuronic acid also.[15-16] It is possible that glucose-cyclo-acetoacetate may act as a precursor of ascorbic acid by first getting converted to glucuronic acid. In that case the reaction sequence can be written as follows :

$$\text{Glucose cyclo aceto acetate} \xrightarrow{(1)} \text{Glucuronic acid} + \text{Aceto acetate}$$

$$\text{Glucuronic acid} \xrightarrow{(2)} \text{Ascorbic acid}$$

The reaction (1) involves oxidation of the glucose part and splitting off of acetoacetate. For the latter, pantothenic acid in the form of coenzyme A may be necessary.

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VIVOTOXINS AND UPTAKE OF IONS BY PLANTS

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PRIMARY loss in permeability of tissues with the onset of toxæmia in cotton (with susceptible variety—K 2) produced by *Fusarium vasinfectum*, resulting in deranged selective absorption of the key metabolite potassium was reported in a general way from this laboratory.[1] Further work in this field of enquiry, using the Lundegårdh air-acetylene spark-in-flame technique (only Ilford Zenith plates were used) on ash samples (leaves) of 18-days-old cotton plants of the susceptible (K 2) and resistant (Cambodia) varieties grown in sterilized garden soil, with and without *F. vasinfectum* inoculum, revealed some new and interesting results, permitting of more elaborate analysis of this intricate imbalance in uptake due to plasmolytic changes brought about in root tissues in the presence of vivotoxins. The technique used was essentially as detailed before[1] except that the ash samples were derived by a wet ashing method[2] and not by dry ashing at high temperatures which is known to produce some loss in metals, as, for instance, potassium.[3]

Since it is a common observation in pot trials that certain plants of the susceptible variety of cotton growing in inoculated soil apparently escape the disease and remain healthy while others show the characteristic vein-clearing symptoms and are wilting, leaves from such plants were also included in this study. The samples thus were: (1) resistant, control; (2) resistant, grown in inoculated soil; (3) susceptible, healthy control; (4) susceptible, grown in inoculated soil, but apparently healthy; and (5) susceptible, wilting plants. The results presented in Fig. 1 clearly indicate that there is a derangement in ionic uptake by plants of both varieties consequent on the presence of the pathogen in the root region, although in the normally resistant variety it is not so pronounced as to upset its normal metabolic functions to any appreciable extent. On the other hand, despite the apparently healthy condition of certain plants of K 2 grown in inoculated soil, a considerable degree of imbalance in the uptake as well as accumulation of the elements studied was noted.

The net percentage loss or gain in the elements due to infection in the soil is given in Table I. Although the resistant variety showed a slight loss in the three major elements, their ratios remained practically unchanged (Table II). The manganese content registe no change and the fall in ratio between and the major elements was negligible. On contrary, the ratios between all the eleme

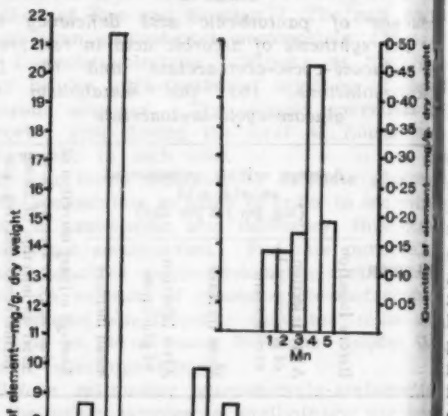

FIG. 1. The quanta of K, Ca, Mg and Mn in Cott leaves. (1, 2, 3, 4 and 5 in X-axis refer to the sampl as given in the text.)

showed a considerable fall in the two infect series of the susceptible variety. Table I sho

TABLE I

Percentage loss or gain in elements due to infection in soil

Element	Resistant	Susceptible	
		Apparently healthy	Wilting
K ..	23·3 (−)	80·3 (−)	99·5 (−
Ca ..	24·5 (−)	29·1 (−)	57·0 (−
Mg ..	23·7 (−)	95·0 (+)	38·1 (−
Mn ..	0	170·6 (+)	11·8 (+

TABLE II
Ratios between elements

Samples	Resistant 1	Resistant 2	Susceptible 3	Susceptible 4	Susceptible 5
K : Ca ..	0·9	0·9	2·5	0·7	0·03
K : Mg ..	2·3	2·3	10·1	1·1	0·8
Ca : Mg ..	2·6	2·6	4·1	1·5	2·9
K : Mn ..	61·4	47·6	125·3	9·1	0·5
Ca : Mn ..	70·9	52·9	50·6	13·3	19·5
Mg : Mn ..	27·1	20·7	12·4	8·7	6·8

a varied accumulation of the different elements in these infected plants. There was an enormous rise in the amount of magnesium as well as manganese in the infected but apparently healthy plants. In the wilting plants also manganese level was higher than in the healthy control plants. But the key metabolite K registered a great loss in the susceptible plants following infection and a look at the ratios between the elements in these plants, as compared to that in the healthy, shows the thorough imbalance in ionic uptake. It is very interesting to note that the apparently healthy plants of the susceptible variety growing in inoculated soil suffer from a gross derangement in metallic uptake while their counterparts in the resistant variety do not, to any significant extent. In the case of the former, a clear loss in the semi-permeability of the cells is strongly indicated which may be due to the action of vivotoxins, although, for some reason or other, the toxin may not as yet be in sufficient amounts to produce visual symptoms and hence their apparently healthy condition. Perhaps with increase in age these may also succumb to toxic action. On the other hand, the slight disturbance in the normally resistant plants grown in infected soil may only be the result of its response to the presence of the pathogen in the root region, but which is unable to establish itself in this host. It is strongly doubted that toxin production itself is prevented in the root region of the resistant host. This point is under investigation and is expected to give much valuable clue to this disease mechanism.

There seems to be a strong case for following up these changes in more cotton varieties, both susceptible and resistant, as indeed, this study has opened up new vistas into the genetic nature of the control of the uptake of these metals by root systems, for primarily the pattern of uptake of the quanta of different metallic ions seems to be so different in the two varieties of cotton studied [an *arboreum* (K 2) and a *hirsutum* (Cambodia)], even without the complicating factor of the presence of the toxin in the region of the rhizosphere.

The question uppermost in our minds is whether the damage to the semi-permeability of the tissues due to toxæmia is permanent or whether at all the antidoting of the toxin *in vivo* in the region of the root plasma membrane (presumably by a process akin to chelation) is possible so as to register a partial or a complete recovery of the wilting plant.

One of us (L. S. D.) thanks the National Institute of Sciences of India for the award of an I.C.I. (India) Fellowship.

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CALCUTTA, MADRAS AND BOMBAY UNIVERSITY CENTENARIES, 1957

THE Centenaries of the Calcutta, Madras and Bombay Universities, whch were celebrated a fitting manner during January-February of this year, augur well for the future of higher learning and research in the country.

As Pandit Jawaharlal Nehru, the Prime Minister of India, observed during the celebrations at Madras, the end of one epoch is also the beginning of another, and the recent celebrations may as well be associated with the inauguration of the next hundred years for these centres of learning and what they are bound to usher in. Our hopes are that the record of achievement will be even more splendid.

PREVENTION OF TUBERCULOSIS

THE eradication of tuberculosis depends as much on efficient preventive measures as on the cure of those suffering from this disease. In this connection, the following conclusions presented by Prof. Frederick Heaf in a paper read in the Section of Diseases of the Chest at the Annual Meeting of the British Medical Association, Brighton, 1956, will be read with interest.

In the prevention of tuberculosis the removal of general predisposing causes of ill-health is essential. On this foundation we can establish our special measures for the discovery of active infectious cases and the protection of the healthy from developing the disease. But the responsibility for the prevention of tuberculosis does not rest only on the medical profession. It must be borne by all sections of the community. The physician needs the help of the informed layman and others who can influence public opinion, because to obtain permanent progress the individual must eventually be willing to act, without compulsion, for his own benefit.

Tuberculin-testing, miniature radiography, B.C.G. vaccination, and antibiotics are the four cardinal points of the compass that must be our guide to the eradication of tuberculosis, but the compass must be firmly based and binnacled by sound general public health measures. The importance of the primary infection and the lesion it produces can hardly be overestimated, for the initial reaction of the tissues to the invasion influences the subsequent course of the disease. It is therefore essential that future preventive measures should be directed, in the first instance to discovering and treating the primary lesion whenever it occurs. To do this serial tuberculin-testing of children and establishing free static miniature radiography services in all large towns are advocated. Every effort must be made to prevent the spread of infection from persons with active disease who live in or enter countries where the incidence of infection is low.

This is the major reason why tuberculosis has become an international problem. The more favoured nations must assist those in whose country, the disease is still a major public health problem, not only because of the danger that lies at the door, but because the elimination of disease and relief of suffering are duties that the healthy must accept for the benefit of all mankind.

INSECT CONTROL BY RADIATION

THE losses occasioned by insect pests in stored products amount to well over a billion dollars a year in the United States alone. Losses occur in stored grains before processing, in packaged food products, in clothing and other textiles, and in lumber and wooden articles. Control of the insects responsible for these losses is a large-scale problem, and tremendous savings could be achieved by the development of methods more effective than those currently in use.

There are several forms of radiation that can be used to kill insects, each having its own characteristics, advantages, and disadvantages. A number of investigators have tested the effects of sound waves above the audible range, especially between 50,000 and 100,000 cycles per second, and have found that they are destructive to living organisms. It is not certain, however, that the apparatus for producing such frequencies is adaptable to large-scale treatment of material containing insects. A more promising form of energy is found in high-frequency radio waves which cause what is known as dielectric heating in non-conducting bodies. Soderholm has reported the use of this method on rice weevils and on the pink bollworm. The apparatus used produced electric fields with alternating frequencies of 40 megacycles per second. This raised the temperatures of the material in the field and killed the insects. The heating was not high enough to damage the grain or cotton seed that surrounded the insects. The weevils were killed by 1-second exposure, the bollworms after 1 to 29 seconds in the field.

Recent developments in physics have produced several new sources of radiation, some of which seem certain to be applicable to insect control. All derive either from some type of particle accelerator or from the radio-active decay of various elements.

Particle accelerators produce beams of subatomic particles travelling at extremely high speeds. The particles may be electrons, protons, or other kinds of atomic fragments. Only electron accelerators are of interest for insect control, because the others are far too close and elaborate. All electron radiation, however, is limited to relatively thin layers of material

or to surface irradiation of thick objects, but his disadvantage is balanced somewhat by the elatively light shielding required to protect ersonnel. Another advantage is that, unlike adio-active radiation, the electron beam can e shut off when it is not wanted, which makes or safer and more convenient operation.

Radioisotopes offer another and very useful ource of radiation. There are already in use number of cobalt-60 units of high intensity, ated in thousands of curies, whose rays can enetrate deeply. Heavy shielding must be rovided to protect personnel from the effects f this radiation.

The operation of nuclear reactors, or piles, esults in the accumulation of very large quanities of radio-active elements of various inensities and with differing decay periods. Both amma and beta (electron) radiation can be extracted from these wastes, or, if desired, the crude waste need only be concentrated and the total radiation used. Still another source of radiation from the uranium reactor would be the spent fuel rods from the pile. Any of these sources of radiation, which are now largely useless, could be fabricated into units of suitable size and intensity to furnish radiation for processing large quantities of products of many kinds.

Are the devices described here practical solutions to the problem of killing insects that infest large quantities of food and other packaged products? At present there are no cost estimates based on actual operation of equipment for destruction of insects, but it is quite possible that in course of time they become feasible economically. (*Science* 1956, 124, 1011.)

TIDAL POWER STATION

OR some months past, the estuary of the river, *Rance*, which flows into the sea between aint-Malo and Dinard in Brittany, in France being subjected to systematic geological oundings. The object of this study is to find e best location for a 2,300 foot-long dyke, hose construction will require more than 5,000,000 cubic feet of concrete.

A special feature of the dyke is that it will e both a dam and a power station. With 33 vities bored into the concrete and each fitted ith a 9,000-kilowatt apparatus known as a ulb-unit", the dyke-power-station will be ble to generate 800 million kilowatt-hours nnually. French technicians hope that the ance plant will start operating by 1960, and, as a prototype of tidal power stations, it will provide them with essential technical data for even more ambitious projects. One of these, already under study, provides for the building of a series of power plants in the Bay of the Mont Saint Michel, on the borders of Normandy and Brittany, with a total capacity of ten to fifteen million kilowatts.

Work on the Rance project is being watched with interest by technicians in many countries. It has been estimated that the potential tidal power wasted along the world's coastlines is approximately 36 billion kilowatt-hours a day. All this energy is there for the taking, and in years to come it should provide at least a partial solution to the world's power problems.

CRYOTRON

OW temperature research has led to the deve- lopment of the 'cryotron' which can serve a nearly perfect electronic switch. In its mplest form, the cryotron consists of a straight ece of wire approximately 1/10 of an inch ng, wound with a single layer of control wire out the size of a human hair. This very all device may have far-reaching influence the future development of electronic comting machines.

The cryotron operates in a bath of liquid lium, only a few degrees above absolute zero; at such extreme low temperatures, many metals are superconducting, but they regain their normal resistance in the presence of a sufficient magnetic field. When the cryotron is cooled by liquid helium, the central wire can be made superconductive or resistive at will by raising or lowering the magnetic field created by the control current flowing in the surrounding coil. Thus the cryotron performs the same functions as any electronic switch—it makes, breaks or changes connections in an electrical circuit.

LETTERS TO THE EDITOR

USE OF DIFFERENCE-PATTERSON METHOD IN CRYSTAL STRUCTURE ANALYSIS

THE suggestion by Buerger[1] that the Difference-Patterson method could be used for structure analysis has recently been studied further by Kartha and Ramachandran.[2] They have indicated how the method could be used with success in a majority of the space groups. In the light of this it would be interesting to use the method in a few cases and study the utility of the same in two-dimensional projections. This note describes the results obtained in the case of four pairs of isomorphous crystals. In all these cases the crystal structure was known, hence a check was available on the results of the investigation.

1. *Hexamethylenediamine dihydrochloride and dihydrobromide.*—The crystal structure has been worked by Binnie and Robertson.[3] The belong to the space group $P\,2_1/c\,(C_{2h}^5)$ and ha four molecules per unit cell. Hence the re placeable atoms are eight in number. The D-P projection was made on bc plane from the I values of Robertson. The projection did no yield a clear image of the structure. A comparative study of this projection with the Pat terson and electron density projections as ob tained by Binnie and Robertson[3] indicate that the peaks in the D-P diagram are du to vectors from replaceable to replaceable (R-R) atoms. The peaks due to vectors fro replaceable to non-replaceable (R-NR) atom could not be located.

2. *Cupric and Chromous Acetates.*—The cry tals belong to the space group $C\,2/c\,(C_{2h}^6)$ wi four molecules per unit cell. The structur has been determined by Niekerk and Schoe

ning.[4] From their observed |F| values a D-P projection was made on the bc plane. On drawing the contours, the peaks were found to be due to replaceable atoms only. To get a structure image, the weights of the peaks should in general be different, since one can then differentiate peaks due to R-R vectors from those due to R-NR vectors. In this case, however, it was noticed that the peaks were nearly of the same weight, thus making it difficult to arrive at the structure uniquely. Further, due to the large number of replaceable atoms, eight in number, the R-NR peaks might have been masked. A $(|F_1|-|F_2|)^2$ synthesis was also made to get the vectors between the replaceable atoms only. The peak positions observed in this case did not materially differ from those in the D-P projection, indicating that the vectors between R and NR atoms are not resolved.

3. *Magnesium and Nickel Acetates.*—These crystals belong to the space group $P\,2_1/c$ (C_{2h}^5) with two molecules per unit cell and so the number of replaceable atoms are only two. The crystal structure has been completely determined.[5,6] The Difference-Patterson projection gave more or less the true positions of the non-replaceable atoms. Except for one carbon atom C_1 (Fig. 1), all the other atoms were distinctly resolved. Although the magnesium atom occupies a special position, since it is on the centre of symmetry of the molecule, no disturbing effects, such as doubling, were noticed which would have otherwise occurred because of the special positions occupied by replaceable atoms. The weights of the peaks also confirmed that the peaks are due to R-NR vectors.

4. *Caryophyllene Alcohol Chloride and Bromide.*—The space-group is $P\,2_12_12_1$ (D_2^4) with four molecules per unit cell.[7] A Difference-Patterson projection was made on the bc plane. In the projection the peaks due to R-R vectors and the peaks due to R-NR vectors could be easily separated out and the whole structure was derived by making use of a suitable translation, as was done by Sasisekharan[8] in case of di-p-tolyl telluride and selenide.

Although in principle the D-P method could be applied to a majority of space groups, in practice it appears that in two-dimensional projections, if the number of replaceable atoms is large, the peaks due to R-NR vectors do not get resolved. If the replaceable atoms are four or less, the D-P method could probably be used with success.

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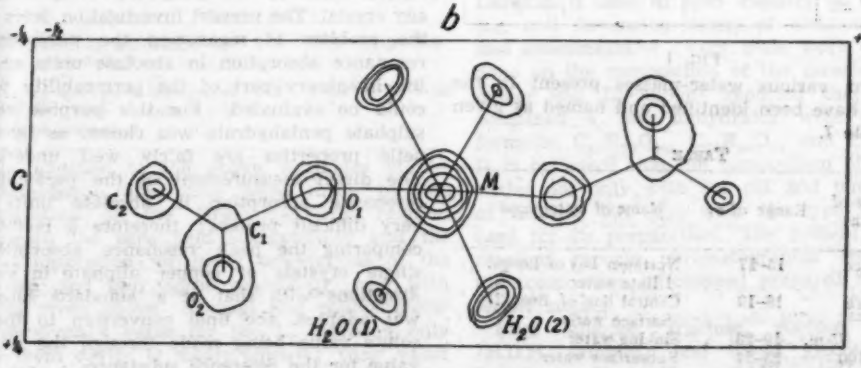

FIG. 1

WATER-MASSES OF THE WESTERN CENTRAL BAY OF BENGAL DURING NOVEMBER

A MEAN T-S curve has been established from the temperature and salinity observations made upto a maximum depth of 350 m. in the western central Bay of Bengal during November. The temperature-salinity plots for the various stations are shown on the T-S diagram along with the mean T-S curve in Fig. 1. From this T-S

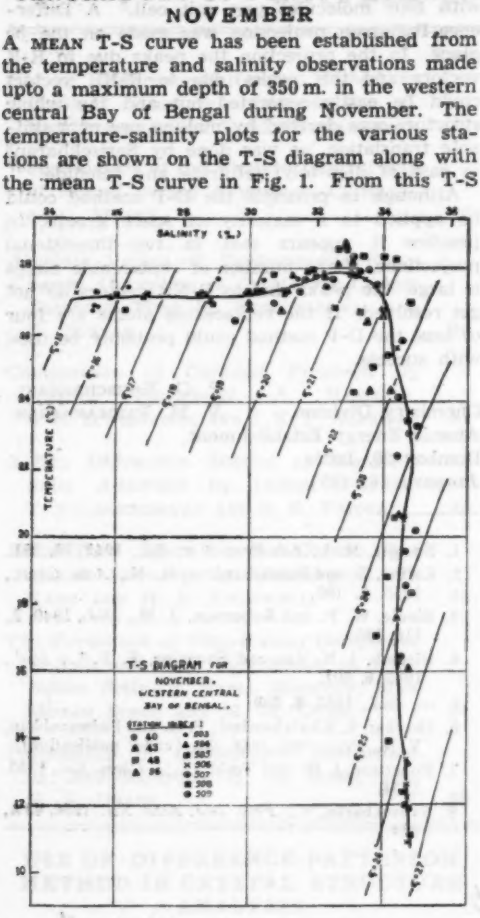

FIG. 1

diagram, various water-masses present in the region have been identified and named as given in Table I.

TABLE I

Range of depths	Range of σ_t	Name of water-mass
Surface	15–17	Northern Bay of Bengal Dilute water
Surface	18–19	Central Bay of Bengal Surface water
Upto 75 m.	19–23	Sinking water
75–100	23–24	Subsurface water
100–175	24–25	Intermediate water
175–300	25·26·5	Indo Pacific water
300–350	>26·5	Indo-Pacific equatorial water

Items 1 to 4 of Table I are mainly classified on the basis of σ_t whereas items 5 to 7 are classified on comparison with the standard T-S characteristics[1] (not shown in the figure) of the Indian Equatorial, Pacific Equatorial and Northern Pacific Central water-masses. Items 1 and 2 refer to the surface waters only, the former relating to the near-shore waters and the latter to the offshore waters.

The σ_t and depth ranges given in the table are only approximate values and the classification of the water-masses given here has to be taken as tentative.

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ABSOLUTE VALUES OF PARAMAGNETIC RESONANCE ABSORPTION IN CRYSTALLINE COPPER SULPHATE

THE magnetic permeability of a crystalline substance is in general represented by a second order tensor with complex components. The real and imaginary parts of the tensor components represent the susceptibility and the absorption effects respectively. Both the components are in general dependent on the frequency of observation and the magnitude of the applied magnetic field. While the tensor components of susceptibility have been evaluated for many substances both by static measurements and by the more powerful magnetic resonance measurements there is no complete measurement of the imaginary component for any crystal. The present investigation deals with the problem of measuring the paramagnetic resonance absorption in absolute units so that the imaginary part of the permeability tensor could be evaluated. For this purpose copper sulphate pentahydrate was chosen as its magnetic properties are fairly well understood. The direct measurement of the paramagnetic resonance absorption in absolute units is a very difficult process; therefore a method of comparing the peak resonance absorption of single crystals of copper sulphate in various directions with that of a standard substance was adopted, the final conversion to the absolute value being made through the absolute value for the reference substance.

The measurements were made in a conventional paramagnetic resonance apparatus using

known weights of single crystals of copper sulphate and manganous sulphate as reference substance; knowing the shapes of the paramagnetic resonance of the individual curves as represented by the ratio of the ordinates at two different values of the applied magnetic field, and knowing the ordinates of absorption for the mixture, it is possible to calculate the peak-to-peak ratio of the two substances. Extensive investigations were made covering a large number of crystal orientations and weight ratios. It is well known that though copper sulphate belongs to the triclinic class, it is practically uniaxial in its magnetic properties. Following earlier authors we give here the magnetically important directions L_1, L_2, L_3 and L_4 and their co-ordinates as follows:

$L_1 = (154°, 64°, 51°)$;
$L_2 = (78°, 130°, 52°)$;
$L_3 = (66°, 86°, 42°)$;
$L_4 = (70°, 41°, 69°)$;

all the angles being measured from the three crystallographic axes *a*, *b*, *c*, respectively. The L_1 direction is the unique axis and the other directions are all perpendicular to it. The present measurements were made in the L_1-L_3, and the L_2-L_4 planes at close enough intervals (approximately 10° to 20°); measurements of complete resonance curves giving *g* value, line width, peak absorption, and integrated absorption were made. The line width and *g* values agree reasonably well with those of Bagguley and Griffiths,[1] though our line width values are somewhat lower than theirs. Table I gives the results of the measurements.

TABLE I

Direction	L_1	L_2	L_3	L_4
Peak value of absorption in units of 10^{-2} cm.[3]	7·9	3·2	5·9	2·9
Value of absorption intergrated over the entire resonance; in units of gauss cm.[3]	6·8	7·37	7·39	7·38

In addition to the above, estimates of the paramagnetic absorption were made by the application of the Kramers-Kronig relation between the zero field susceptibility and the total absorption for many orientations of the crystal, and they agree reasonably well with those given above. Kumagi and collaborators[2] have given a value for the L_1 direction only got from cavity Q measurements; their value of 12×10^{-2} cm.[3] is larger than ours. From the detailed measurements made by us it appears that the Kramers-Kronig relation is generally valid and that the imaginary component of the permeability tensor has principal directions in copper sulphate the same as those of the susceptibility. It must be remembered, however, that the measurements given above are necessarily limited to resonance conditions only. This fact must also be borne in mind when trying to compare the average of the principal values with that of the powder; the average cannot be simply taken because the field at which resonance takes place is different for different orientations. Thus in the present case the average value is about 5, whereas the measured value for a powder sample is about 2·4. Details of the investigation will be published elsewhere.

The authors' thanks are due to Prof. R. S. Krishnan for his kind interest. One of us (G. S.) is indebted to the Department of Atomic Energy for the award of a research fellowship.

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COMPOSITION OF CARAMEL PREPARED BY HEATING SUGARS

DURING the manufacture of cane sugar, caramel which is a mixture of nitrogen-free organic compounds,[1] is produced due to overheating of sucrose or its decomposition products.[2,3] It not only imparts colour to the sugar crystals, but also inhibits the rate of crystallisation.[4] Caramel is used in food industry as a colouring and flavouring agent of alcoholic drinks and sweetmeats.[5,6] Very little work has been done on the composition of the caramel. Schumaker and Buchanan[7] reported that caramel contained a few anhydrides with empirical formulæ, $C_{12}H_{20}O_{10}$, $C_{24}H_{36}O_{18}$ and $C_{36}H_{50}O_{25}$. It is believed[8] that the composition of caramel varies not only with the pH and temperature of heating but also with the type of sugar used for its preparation. The present communication reports chromatographic studies on the composition of caramel prepared from different sugars.

Pure glucose, fructose, sucrose, maltose (B.D.H. samples) and liquid glucose (from Ravalgaon Sugar Farm, Ltd.), were used as raw materials; from these, caramel was

prepared by two methods: (*a*) heating the sugar as such at 200° C., and (*b*) heating the sugar in solution phase in presence of alkali at 100° C. The details of the procedure were given elsewhere.[9] Caramel was separated from the system by precipitation with alcohol. The caramels obtained from different sugars were examined chromatographically using Whatman filter-paper No. 1 and *n*-butanol-ethanol-water mixture as the solvent.[10]

Fig. 1 gives a typical set of chromatograms indicating the constituents of the caramels; in

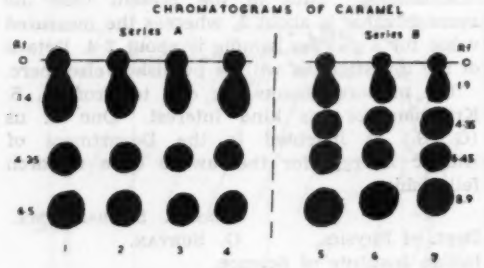

FIG. 1. Chromatographic Studies of the Composition of Caramel. Series A refers to the caramels prepared by heating sugars with alkali in the solution phase and series B to those prepared by heating sugars as such. 1 and 5 from dextrose; 2 and 6 from levulose; 3 from maltose; 4, liquid glucose; and 7, mixture of sugars. Time of running the chromatograms for series A was 96 hr. and for series B, 72 hr. Temperature 35° C. The standard reference value employed for computation of R_f values of the spots of caramel was taken as 13·6 for levulose (not shown in Fig. 1).

this, series A refer to the caramels prepared by method *b*. It was interesting to note that there existed four reducing compounds with roughly the same R_f ($\times 100$) values of 6·5, 4·35, 1·4, 0 (reference value—levulose 13·6) in all the caramels prepared from different sugars. Contrary to the general belief was the observation that whether a single sugar or a mixture of sugars was employed for caramelisation, the same four reducing compounds were detected. This is due presumably to the production before caramelisation of an intermediate equilibrium mixture of glucose, fructose and mannose where sugars were heated in alkaline solutions as envisaged in the Lobry de Bruyn and Aberde van Ekenste in transformation.[11] The observation of a spot with R_f value of 0 (on the reference line) indicated the presence of one (or more) reducing substance(s)* of relatively high molecular weight.

Chromatograms in Fig. 1 B which refers to the analysis of caramel prepared by heating sugars as such (method *a*) indicated the presence of another reducing compound with R value of 8·9, in addition to the four detected in caramels prepared by the method *b* (Fig. 1 A). As in method *b*, the same number of reducing compounds with equal R_f values were noticed whatever may be the sugar employed. This observation points out that the van Ekenstein transformation known to take place in heated alkaline sugar solutions, appears to take place when sugars are heated as such.

The results in Fig. 1 show clearly that the composition of the caramel varies not with the sugar used, but with the method employed for its preparation.

The authors' thanks are due to Professor S. N. Gundu Rao and Professor K. S. G. Doss for their kind interest and encouragement.

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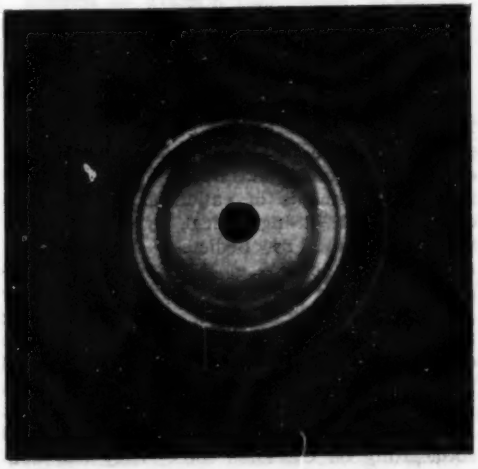
X-RAY DIFFRACTION STUDIES OF INORGANIC SALTS ADSORBED BY COTTON FIBRES

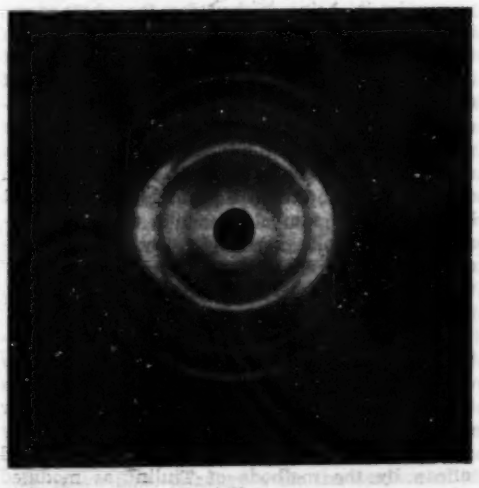
DETAILED studies have been reported in the past[1–5] on the fine structure of deposits of noble metals on cellulose as revealed by X-ray diffraction and optical methods. Similar studies on the fine structure of adsorbed dyestuffs on textiles have been done mostly by optical methods on account of the low X-ray scattering power of adsorbed organic dyes in the usual concentration range. However, there is some X-ray work in this connection.[6,7] In this laboratory, X-ray studies have, therefore, been instituted in order to investigate the fine structure of some simple inorganic compounds when adsorbed on cotton fibres. The compounds were chosen on the basis of their high scattering power for X-rays, low solubility in water and relatively high affinity for cotton. Typical

examples are the sulphides of lead and mercury and the chromates of lead and barium. These and similar salts were precipitated inside the fibre by impregnating the scoured fibre with an aqueous solution of a suitable salt of the metal and then transferring the fibres to the appropriate reagent. The treated cotton was soaped and boiled, or combed repeatedly, in order to remove surface deposits.

The X-ray diffraction pictures of the treated fibres showed powder patterns of known lattices of the salts (Fig. 1). The diffraction rings were somewhat diffuse, indicating that the linear dimensions of the crystallites were of the order of a micron or less. At present, the size and shape of the crystallites are being assessed from the measured line breadths.



Lead Iodide



Lead Chromate

FIG. 1. X-ray Diffraction Patterns of Cotton Fibres Containing Adsorbed Inorganic Salts.

In the case of a few salts, such as lead iodide and lead chromate, the powder patterns indicated that there was preferred orientation of a crystal axis parallel to the fibre axis. This result is in contrast to the random orientation which has been reported for metal deposits. Ramachandran and Ambady in a recent paper[8] report the production of highly oriented deposits of inorganic salts on collagen. The nature of the preferred orientation of adsorbed materials on cotton and the conditions under which the effect is best obtained are now under study.

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SOLAR FLARE EFFECT ON THE COSMIC RAY MESON INTENSITY AT GULMARG

COSMIC ray meson telescopes have been in operation at Gulmarg, Kashmir (altitude 9,000 ft., geomagnetic latitude 23° 5′ N.) for the last few months at the field station of the Physical Research Laboratory, Ahmedabad. Each telescope measures a triple coincidence rate of 3 G.M. counters each of length 2 ft. and diameter 1½ in. The separation between the counters and their orientation are such that the semi-angles of each telescope in the east-west and north-south planes are 5° and 56° respectively. About 8 cm. of lead are interposed in between.

On 23rd February 1956, there was a big solar flare of magnitude 3. The flare was associated with increase in cosmic ray intensity at various latitudes and numerous reports have appeared from observing stations all over the world. Sarabhai *et al.*[1] have reported an average increase of 6% at Trivandrum, Kodaikanal and

Ahmedabad during the hour following the flare. At the time of the solar flare, three telescopes were in operation at Gulmarg. The rate of each telescope was only about 700 counts per hour and the standard deviation was rather large (about 4%). It was observed, however, that all the three telescopes recorded increases in cosmic ray intensity on 23rd February 1956. To reduce the statistical errors, data from the three telescopes have been combined and the hourly values for the period February 21-25 have been plotted in Fig. 1 (*a*). In spite of the

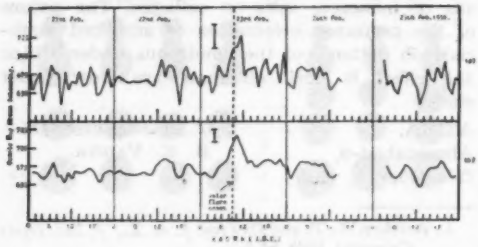

FIG. 1. Hourly values of cosmic ray meson intensity for the period 21-25 Feb. 1956.
(*a*) Actual values. (*b*) Moving averages over three consecutive hourly values.

large fluctuations in the ground level of cosmic ray intensity, an increase of about 10% (± 2%) is clearly seen during the interval 8 a.m. to 12 noon on 23rd February. Fig. 1 (*b*) gives the moving averages of the hourly values of cosmic ray intensity for three consecutive hourly values, the average thus centred at the middle hour. The increase on the morning of 23rd February stands out prominently in Fig. 1 (*b*). Its magnitude is about 8% (± 1%) and the hour of onset of cosmic ray increase seems to be about 10 a.m. (± 1 hr.). No corrections of any kind have been applied to the data.

The implications of increases of this type at stations in low latitudes have already been discussed by Sarabhai *et al.*[1] Forbush[2] has since reported a 18% increase of ionisation at Huancayo which is almost on the geomagnetic equator but was outside the impact zone at the time of occurrence of the flare on 23rd February 1956. He has also reported a 50% increase in ionisation at the high latitude station of Godhavn (Geomagnetic latitude 80° N.). There is, therefore, a complicated mechanism for storage and scattering of cosmic primaries of solar origin and the estimate of the mean energy and yield of the primaries made by Sarabhai *et al.*[1] would require re-examination.

The authors are grateful to the Atomic Energy Commission of India for financial support of the present work. Thanks are due to Prof. V. A. Sarabhai for helpful discussions.

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THE FORMATION OF CLAY-HUMUS COMPLEXES IN SOILS AND THEIR SIGNIFICANCE IN SOME INDIAN SOILS

THE fact that the inorganic clay and humus exist in intimate combination in soils has been shown by Demolin and Barbier[1] and Mattson[2] from measurements of cation exchange capacity, by Sideri[3] using optical, by Myers[4] using viscometric and by Sedletsky[5] using X-ray methods. In the case of the clay-humus complexes involving protein, it has been shown by Ensminger and GiesKing[6] that this complexing renders proteins more resistant to proteolytic enzyme-action. Tiulin[7] has developed a method for fractionating the clay-humus colloids from a soil by partial dispersion and flocculation. Atkinson and Turner[8] have used this method successfully on Canadian soils. They had both shown that the fertility of a soil is indicated by the proportion of their first group of complexes in it, being higher for the chernozems than for podsols. This was also correlated with the crop yielding power of the soils. It is of interest to know if this is true of the soils of this country and if this proportion can be increased in efforts to raise their fertility. The purpose is to test this, taking a black cotton soil from Padegon (Bombay State) and an acid hill (Cinchona) soil from Munsong (West Bengal) as the nearest analogues to the chernozems and podsolic soils studied by earlier workers and to find out the constituents of the clay that will be needed to form the fertile group of complexes.

Three groups of complexes were quantitatively separated from surface 0-9 in. samples of the two soils mentioned above, as well as composted mixtures of F.Y.M. with either montmorillonite, illite, kaolinite and freshly precipitated oxides of aluminium, iron and silicon by the methods of Tiulin[7] as modified by Atkinson and Turner.[8] 45 g. of the separated clay-mineral (size of particles $< 2\mu$) or

the oxide were mixed with 90 g. of washed quartz sand and inoculated with 15 g. of a fresh sample of the Delhi soil. Farmyard manure (sized to pass through 0·5 mm. sieve) was then added to give 2·0% carbon in the whole mixture. The pH of this mixture was then adjusted to 8·5 by the addition of lime water and then inoculated for two months at 30° C, maintaining the moisture content at about 1/3 saturation capacity and stirring once a week. The results are given in Table I.

TABLE I

Content of Tiulin's clay-humus complexes in soils and synthetic clay mineral mixtures

Sample	Content of clay-humus complexes			Ratio Group I / Group II
	Group I % on the sample	Group IIa %	Group IIb %	
Padegon black cotton soil	53·80	8·80	7·30	3·34
Munsong cinchona soil	4·90	17·70	14·90	0·154
Montmorillonite mixture	19·24	1·111	2·906	4·79
Illite mixture	10·39	1·59	2·901	2·53
Kaolinite mixture	8·43	1·396	3·303	1·79
Silica mixture	3·18	Nil	trace	very high
Al_2O_3 mixture	Nil	Nil	trace	indeterminate
Fe_2O_3 mixture	2·745	2·90	Nil	0·948

The value of the ratio of Group I/Group II colloidal complexes in Table I is high for the black soil and low for the cinchona soil as may be expected from the order of their fertility by analogy with the western chernozems and podsols. These two groups of soils have values 2·47 and 0·59 respectively for the Russian soils, and 1·75 and 0·77 for the Canadian soils as shown by Russell.[9] The present investigation shows that the formation of the fertile group is favoured by the presence of montmorillonite while the infertile one is favoured by kaolinite. In its behaviour in this regard, the Padegon black cotton soil is like montmorillonite, while the Munsong cinchona soil is like kaolinite mixed with free oxides of aluminium and iron. Because high values for this ratio are obtained by silica amongst the oxides and the 1 : 2 lattice minerals (montmorillonite and illite) having more SiO_2 tetrahedra on their surface than the 1 : 1 lattice minerals (kaolinite) amongst the clay-minerals studied, it can be concluded that the presence of active SiO_2 tetrahedra on the surface of the clay is responsible for the formation of the fertile group of clay-humus complexes. Similarly, the abundance of octahedral groups of Al_2O_3 or Fe_2O_3 seem to favour the infertile 2nd and also perhaps the 3rd groups. The relative abundance of these active components on the surface of a soil clay may therefore determine the relative proportion of the various groups of complexes and hence their soil fertility provided the presence of organic matter and lime is not limiting. This is in conformity with the findings of Raychaudhuri and Baldev Kapoor,[10] we have, from other considerations concluded that in an illitic Kari soil of Travancore, the formation of the first group of clay-humus complexes is limited by the insufficiency of montmorillonite in the soil clay.

Further work and detailed analysis is in progress and will be reported elsewhere.

Division of Soil Science and Agric. Chemistry, Indian Agric. Res. Inst., New Delhi, *January* 2, 1957.

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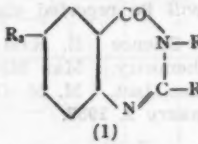
POTENTIALITY OF QUINAZOLONE DERIVATIVES AS ANTIMALARIALS

HIGH antimalarial activity associated with Febri-fugine,[1-3] an alkaloid with 3-substituted-quinazolone-4 structure, led to extensive investigations on these derivatives by Baker and co-workers,[2,4] and several compounds displaying antimalarial activity were synthesised. Coatney *et al.*,[5] studied a few 2-methyl-3-aryl-quinazolone-4 with little encouraging results while Narang *et al.*[6] reported compounds (I, $R_1 = R_3 = H$; R_2 = p-anisyl) as active as quinine when tested against *P. gallinaceum*, in chicks. With a view to study the influence of different substituents at position 2, 3 and 6 on the antimalarial activity of compounds of type (I), several 2-alkyl-3-(aryl or quinolyl)-6-alkyl/halo-quinazolone-4 were synthesized and tested (Table I).

TABLE I

2-Alkyl-3-aryl (or quinolyl)-6-substituted-quinazolone-4 (I)

S. No.	R_1	R_2	R_3	M.P. °C.	Analysis—N%	
					Found	Required
1	CH_3	*o*-ethoxyphenyl	Br	135	7·88	7·80
2	C_2H_5	*p*-methoxyphenyl	Cl	128	9·02	8·90
3	C_2H_5	*p*-ethoxyphenyl	CH_3	170	9·17	9·09
4	C_2H_5	*o*-chlorophenyl	CH_3	88–90	9·57	9·38
5	C_2H_5	*p*-chlorophenyl	Br	171	7·81	7·70
6	C_2H_5	*p*-chlorophenyl	Cl	185	9·03	8·78
7	C_2H_5	2 : 4-dichlorophenyl	CH_3	135	8·83	8·41
8	C_2H_5	2 : 4-dichlorophenyl	Br	134	6·88	7·04
9	C_2H_5	6′-methoxy-8′-quinolyl	H	196–98	12·65	12·69



(I)

Synthesis of quinazolone-4 derivatives by the method of Morgan *et al.*,[7] and Narang *et al.*,[8] was adopted with some modifications to improve the yields.

Equimolar quantities of N-acetyl or N-propionyl derivatives of 5-substituted anthranilic acids[9] were condensed with substituted arylamines (and 6-methoxy-8-amino-quinoline) in the presence of phosphorus trichloride in dry toluene by refluxing for 6 hours. The solvent was distilled off and the mixture dried under vacuum. The product was directly triturated with alkali in the cold, the base filtered, and crystallised from diluted ethanol or methanol as white or pale yellow needles (Table 1). When tested against *P. gallinaceum*, compounds 1 to 8 were inactive at quinine equivalent dosage, while toxic at higher dosages. Compound 9 also showed no activity although it was non-toxic.[10]

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STRUCTURE OF THE AREA SOUTH-EAST OF SATNUR, BANGALORE DIST.

ROCK formations south and south-east of Satnur consist of a number of types of diverse origin (Rama Rao[1]). Such intimate association of rock types of diverse origin has rendered the area classical for study from the point of view of classification of the Dharwar rocks. The rocks show strike and dip, invariably well preserved, so that the structural pattern of the area can be determined with a reasonable degree of accuracy.

The rocks of the Satnur area generally dip eastwards and show varying amounts of dip from place to place. In Fig. 1, is shown the rocks of the area three miles south-east of Satnur. These rocks, i.e., quartzite, basic charnockite, acid charnockite, and cordierite-sillimanite-garnet gneiss have been thrown up into a syncline.

The dip of the two limbs of the fold towards each other, shown by arrows in Fig. 1, indicates a synclinal type of folding. For a given fold, the dip of the beds is maximum at the middle of the limbs; and accordingly, the middle part of the western limb is at the point where angle 55° is marked, and of the eastern limb at the point where angle 82° is marked. The lateral outcrops of quartzite and acid charnockite close to the north indicating the pitch of the fold to the south. Along the axis of a

fold, the dip of a bed is zero; or, if the fold is pitching, is at its minimum.

The axis of a fold may, therefore, conveniently be laid down where the dip is lowest (Fig. 1). Line XY is therefore the axis of the

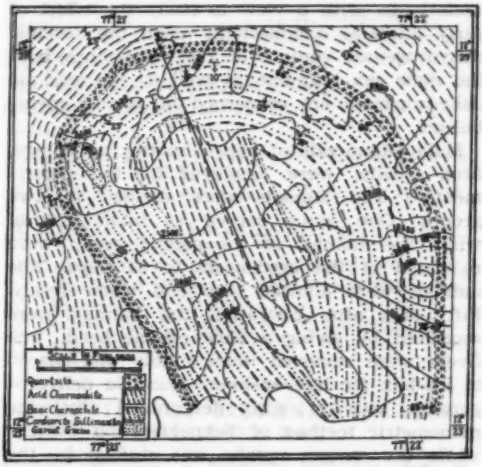

FIG. 1

fold and the dip angles marked 5° and 10° near the axis indicate the southerly pitch of the axis of the fold and thereby the southward pitch of the fold.

This is the first time that a fold pitching southward in Mysore State has been recognised. Pichamuthu[2] has noticed the folds pitching N.N.W. in the Dharwar rocks of both Chitaldrug and Shimoga schist belts. It would be interesting to find out whether in the structural evolution of Mysore, different patterns of folded structure have developed in different localities. Since this southerly pitching fold at Satnur is very close to the southern tip of the Closepet granite, it appears probable that this southerly pitching is a secondary phenomenon due to the intrusion of the Closepet granite.

The author is grateful to Dr. M. G. Chakrapani Naidu for helpful suggestions and to Sri. M. R. Srinivasa Rao for valuable discussions.

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CONE SCALES OF *ARAUCARITES CUTCHENSIS* FROM THE RAJMAHAL HILLS, BIHAR

THE present communication describes three well preserved cone scales of *Araucarites* conforming in size, shape and other characters to the generalized type defined by Seward.[1] The fossils were collected from Onthea and Mirzachowki in the Rajmahal hills; the cone scales from Mirzachowki occur closely associated with twigs of *Brachyphyllum mamillare*. Type specimens of all the three fossils have been preserved in the museum of the Department of Botany, Banaras Hindu University.

FIGS. 1–3

Specimen A (Fig. 1). This was collected from Onthea. The seed scale is almost triangular in outline with a rather narrow base which progressively broadens as we reach the apical portion. There is apparently no prolongation of the tip into a median appendage commonly seen in the cone scales of *Araucarites*. It measures 13 × 8 mm. Placed centrally on the upper side of the scale is a single oval seed measuring 8 × 4 mm. The scale does not show

any ligule. The surface of the scale appears to be smooth.

Specimen B (Fig. 2). This was collected from Mirzachowki. It is slightly bigger than the previous one, measuring 18 × 10 mm. In general shape it is more or less similar to the above one, but there are some noticeable differences. The seed is not found attached to the scale, but its position is indicated by a distinct median depression; it is very narrow at the base and flat at the top and occupies almost the whole length of the cone scale. The surface of the scale and the seed, particularly the latter, is faintly ribbed. The whole scale terminates in a flat appendage.

Specimen C (Fig. 3). This was also collected from Mirzachowki. The scale is fairly big, measuring 23 × 16 mm. It is cuneiform with a distinct dorsal median depression indicating the position of the detached seed. The scale terminates in a small but well-defined mucronate appendage. Just above the median depression is a small triangular mark which might probably indicate the ligule. The surface of the scale is smooth.

All the three fossils are more or less comparable to some of the specimens of *Araucarites cutchensis* described and figured by Feistmantel[2,3] and have therefore been placed under this species. The occurrence of cone scales of *Araucarites cutchensis* along with the twigs of *Brachyphyllum mamillare* appears to be merely a chance association.

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Guntur, *December* 3, 1956.

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EFFECT OF CASTRATION ON SUCCINIC DEHYDROGENASE ACTIVITY IN MALE RAT LIVER

Steroid hormones[1] in general and castration[2] in particular are both known to influence the concentration of some of the enzymes in the different tissues. Thus, a direct relationship between steroid hormones and liver and kidney arginase activity as well as an increase in the concentration of alkaline phosphatase in these organs in castrated rats has been observed by Kochakian.[2] Clark *et al.*[3] showed that castration in the mouse caused a decrease in the concentration of D-amino acid oxidase in kidney but not in liver or intestine. Data, however, are not available on the succinic dehydrogenase content of liver in castrated animals. The present investigation was therefore undertaken with a view to study the effect of early bilateral orchidectomy upon the succinic dehydrogenase content of rat liver, since both the male sex hormone as well as the succinic dehydrogenase are concerned in protein metabolism.

Male albino rats of approximately equal age, bred locally, were employed for the experiments. The animals were divided in two groups. One group served as intact control while the animals of the second group were castrated at the age of 28 to 31 days. The animals were allowed food and water freely. Fifty days after castration the animals were sacrificed by giving a blow on the head. The livers were removed immediately and placed in ice-box for half-an-hour. Succinic dehydrogenase activity was determined by the manometric method of Schneider and Potter,[4] while the oxygen uptake was studied by the direct method of Warburg. Cell suspensions of liver were prepared in ice cold modified Krebs Ringer phosphate buffer containing 0·2% glucose as substrate. 0·5 ml. of a 20% homogenate was placed in a Warburg flask containing sufficient buffer and the material in the side-arm to make a final volume of 3·2 ml. In both experiments the flasks were maintained at 37° C. The experiment lasted for one hour during which readings were taken at 10 minute intervals. It was observed that castration resulted in a significant increase both in oxygen uptake as well as in succinic dehydrogenase activity of the liver tissue as will be seen from Table I.

Table I

Effect of castration on oxygen uptake and succinic dehydrogenase activity in rat liver

Number of animals	Treatment	Average oxygen uptake QO_2	Average succinic dehydrogenase activity QO_2
10	Normal	5·86 ± 0·48*	24·73 ± 1·42
8	Castrated	11·49 ± 0·95 P < 0·001	34·2 ± 1·6 P < 0·001

* Standard error.

So far as the oxygen uptake is concerned, essentially similar results have been reported

by Denison *et al.*,[5] while this work was in progress.

Further studies on the effect of exogenous administration as well as substitution by testosterone on the succinic dehydrogenase activity of rat liver are in progress.

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DETECTION OF METANIL YELLOW IN PULSES *DAL*

METANIL YELLOW, a harmful coal tar dye, is sometimes used to colour certain types of pulse mainly the *arhar* (*Cajanus indicus*) and its detection in routine analysis of pulses is of considerable importance. The following tests have been found useful.

Preliminary test.—A small amount of the whole pulse is treated with a little concentrated hydrochloric acid in a test-tube. In presence of metanil yellow the acid will acquire distinct violet colour.

Wool-dyeing test.—The sample is *partially* broken but not powdered, an aliquot (roughly 20 g.) is treated with about 150 ml. of water and a few drops of concentrated ammonia, and boiled for a few minutes. The solution is decanted from the pulse residues, made just acidic by carefully adding 3 N hydrochloric acid dropwise and a few strands of white wool are put in the solution, which is then heated on boiling water-bath for 30 to 40 minutes with occasional stirring. The coloured wool is washed well under tap and boiled for a few minutes in about 100 ml. of water acidulated with two drops of 3 N hydrochloric acid. The wool is again washed well under tap and the dye is stripped from the wools in weak hot ammonia solution in the usual manner. The ammonia solution of the dye is divided into two parts. One part is reserved for chromatographic tests. The other part is just acidified with 3 N hydrochloric acid and fresh strands of wool are added and dyed as usual by boiling. The coloured wool strips are subjected to the usual spot tests. In presence of metanil yellow, the wools will turn violet when treated both with concentrated hydrochloric acid and concentrated sulphuric acid.

Chromatographic test.—The ammonia solution of the dye as obtained above is evaporated on water-bath to only a few drops and then spotted at the narrower end of a strip (11 in × 1 in.) of No. 1 Whatman filter-paper for ascending chromatogram using the organic phase of the mixed solvent, 4 parts iso-butyl alcohol + 1 part ethanol + 4 parts water. After about 18 hours' run, the metanil yellow will be found to have formed a distinct yellow zone just behind the solvent front. The paper strip is dried and a drop of concentrated hydrochloric acid is added to the yellow zone. Development of violet colour shows the presence of metanil yellow.

The above method may be used to detect metanil yellow in pulse products like *besan*, in sweetmeats like *mihidana*, *bundia*, *jilabi*, etc.

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ESSENTIAL OIL FROM THE FLOWERS OF *PLUMIERA ACUTIFOLIA* POIRST*

Plumiera acutifolia is a common garden tree on the West Coast. The Etablissement Antoine Chiris[1] have reported the constants for a specimen of oil from flowers of *P. acutifolia* imported from India. No reports have yet appeared on the constituents of the oil. The composition of the alcohols in the oil is reported in this note.

The oil used for the present work was obtained by steam distillation of about 25 kg. flowers; the yield was 0·04 to 0·07% when the aqueous distillate was cohobated. Yield of oil was highest when flowers were stored in a closed vessel for some time before distillation, suggesting *post-mortem* generation of volatile constituents as in jasmine, etc. The constants of the oil were: d_{28}^{28} 0·9685; n^{28}_{D} 1·4885; acid no. 20·2; saponification value 123; saponification value after acetylation 257; alcohols as $C_{10}H_{16}O$ 81·1%; esters as $C_{10}H_{15}OAc$ 43%.

The oil, after saponification with alcoholic potash, was treated with phthalic anhydride at

* This work formed part of *M.Sc. Thesis* submitted by T.C.K.M. to the Travancore University in October 1953.

100° C. as usual to separate primary alcohols; the yield of primary alcohols thus obtained came to 68% of the saponified oil. The alcohols had n^{29}_{D} 1·4810 and had a fine rose odour. It was examined by oxidation with Beckmann's chromic acid mixture and chromatography of the dinitrophenylhydrazones obtained from the oxidation products on an alumina column using petrol ether as the developing solvent. Four major and two narrow zones developed. The major zones gave derivatives of citral, m.p. 110° C., citronellol, m.p. 76-78° C., farnesal, m.p. 106° C., and phenylacetaldehyde, m.p. 120-22° C., which were identified by mixed melting points. The minor zones gave derivatives, m.p. 138-40° C. and 110° C. which were not identified.

The residue after treatment with phthalic anhydride contained linalool as indicated by the isolation of citral dinitrophenylhydrazone from its chromic acid oxidation product. The oil thus appears to consist mainly of the primary alcohols geraniol, citronellol, farnesol, and phenylethyl alcohol either free or esterified, together with some linalool.

We are grateful to Prof. K. N. Menon, Professor of Organic Chemistry, University of Madras, for guidance.

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TWO NEW PHYTOPATHOGENIC BACTERIA ON VERBENACEOUS HOSTS

Two plant bacterial diseases inciting extensive spotting on the leaves of *Duranta repens* L. and *Lantana camara* L. var. *aculeata* Mold., were collected at Panchgani (Bombay). A comparative study of the two disease inciting organisms with regard to their morphology, biochemical reactions and pathogenicity indicated that the two were distinctly separate species. The organisms also failed to cross-inoculate or infect other verbenaceous hosts including *Clerodendron phlomoides* L. and *Tectona grandis* L. on which *Xanthomonas* spp. have previously been described by Patel *et al.*[1] The organisms are hence presented as new species and named *Xanthomonas durantæ* sp. nov. and *X. lantanæ* sp. nov. respectively.

On the variety of *Duranta repens* grown as hedge plants in the hill stations, the bacterium incites the formation of spots with light brown centre, which to begin with are small and circular but subsequently enlarge and become angular. The margin of the spots appear slightly raised and give a depressed appearance to the brownish centre. The bacterium which is pathogenic only to *Duranta repens* has the following technical description:

Xanthomonas durantæ Srinivasan, Patel & Thirumalachar.

Short rods with rounded ends, single but rarely in pairs, measuring $1·7 \times 0·8\,\mu$; gram negative, capsulated, non-spore-forming, non-acid-fast, motile by a polar flagellum; colonies on potato dextrose agar plates circular with entire margins, smooth, glistening, butyrous, 7-9 mm. in 8 days, Barium yellow (R); heavy growth in beef-peptone broth; growth on potato cylinders copious, flowing, Reed yellow (R); gelatin liquefied; starch hydrolysed; casein digested; milk peptonised with a soft curd at the base; litmus reduced; ammonia and hydrogen sulphide produced from peptone; nitrates not reduced to nitrites; indol not produced; M.R. and V.P. tests negative. In a peptone-free medium, acid without gas from dextrose, lactose, sucrose and mannitol; no growth in salicin and dulcitol; alkali from acetic acid; aerobic; thermal death-point about 53° C.; optimum temperature for growth 28-30° C.

On leaves of *Duranta repens*, leg. M. J. Narasimhan, Panchgani, August 19, 1955.

On *Lantana camara* var. *aculeata* the symptoms are formation of angular, water-soaked spots, deep-pink in colour and often with a whitish or pale brown centre. The spots when numerous may hasten defoliation. The organism which has so far been found to be restricted only to *Lantana* species, has the following brief technical description:

Xanthomonas lantanæ, Srinivasan, Patel & Thirumalachar.

Short rods with rounded ends; single or in pairs, measuring $1·5 \times 0·7\,\mu$; gram negative, capsulated, non-spore-forming, non-acid-fast, motile by a polar flagellum; colonies on potato dextrose agar plates circular with entire margins, butyrous, Citron yellow (R); abundant growth in beef-peptone broth with a good pellicle and heavy sediment; growth on potato cylinders abundant, flowing, Citron yellow (R); gelatin liquefied; starch hydrolysed; casein digested; milk peptonised with curdling; litmus rapidly reduced; ammonia and hydrogen sulphide produced from peptone; indol not produced; nitrates not reduced to nitrites; M.R. and V.P. tests negative; in a peptone-free medium, acid

without gas from dextrose, sucrose, lactose and mannitol; no growth in salicin and slight alkali in acetic acid; Loeffler's blood serum rapidly liquefied; aerobic; thermal death-point about 52° C.; optimum temperature for growth about 29-30° C.

On leaves of *Lantana camara* var. *aculeata*, leg. M. J. Narasimhan, Panchgani, August 16, 1955.

Plant Path. Lab., Agric. College, Poona, *December* 8, 1956.

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MORPHOLOGY OF THE FEMALE GENITAL CHAMBER IN *EMMALOCERA DEPRESSELLA*, ROOT-BORER MOTH OF SUGARCANE

According to Tams,[1] the genital armature in many groups of insects, both in the male and the female, presents characters valuable in the identification of different species. Kapur[2] found this to be true in the case of crambinid moth-borers of sugarcane. Cheema[3] has studied the morphology of the root borer moth, but his descriptions are very brief and incomplete. He has not described the genital armature of the male or the female. The present note briefly describes the results of studies on the position and the detailed morphology of the genital chamber and genital opening in the female moth of *Emmalocera depresella*.

The genital chamber lies on the 8th abdominal sternite; and the ostium or the genital opening, which forms the external opening of the vagina, lies laterad of the 8th sternite, unlike the genital opening of other insects, including the sugarcane moth-borers, where it is situated ventrally on the 8th sternite. The genital chamber constitutes an external pocket of the body wall with a large median internal pouch and two lateral pouches. One of these, *viz.*, the left one, becomes the functional opening of the vagina for copulatory purposes and is sunk in the folded wall. The other lateral pouch is non-functional and seems to have no connection with the vagina. The median pouch is functionally the vagina, but is a part of the genital chamber (Fig. 1), as are also the lateral pouches. The non-functional pouch seems to have become folded completely. It may be recalled that a similar type of genital chamber has been observed to exist in the case of the honey bee which is situated as a shallow genital cavity concealed above the 7th abdominal sternum at the base of the sting as described by Snodgrass.[4]

FIG. 1. F.L.P.—Functional lateral pouch, G.C.—Genital Chamber; G.O.—Genital opening; N.L.P.—Non-functional lateral pouch; Ovp.—Ovipositor; Vag.—Vagina.

The morphology of the structures noticeable indicates that this moth-borer has had its origin absolutely independent of the other species of sugarcane-borers of the family *Pyralidæ* and is primitive in development. Such a type of structural development in Lepidoptera appears to be the first of its kind to be recorded. It is even more interesting to note that the posterior part of the 7th sternite also takes part in the formation of the genital chamber, which is unique in type amongst the sugarcane moth-borers. A detailed account of the female genitalia is being published separately.

The author is deeply indebted to Shri K. L. Khanna, for his valuable encouragement and guidance.

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V. D. Puri.

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CONTROL OF *DROSICHA STEBBINGI* VAR. *OCTOCAUDATA* GREEN

MANGO MEALY BUG [*Drosicha* (*Monophlebus*) *stebbingi*] is a very serious pest of several fruit trees, *viz.*, peach (*Prunus persica* Siev. & Zucc.), plum (*P. domestica* L.), *Citrus* spp., jak (*Artocarpus integrifolia* L.f.), papaya (*Carica papaya* L.), etc., but causes maximum damage to mango (*Mangifera indica* L.).

Eggs laid in the soil during April-May, hatch in the following December-January. During this period, young nymphs may be seen crawling in huge numbers in search of host plants. The young nymphs crawl up the stems of plants up to the growing tips, where they fix themselves, suck the juice and thus gradually grow in size. In the case of mango, they are seen in clusters adhering to the mid-ribs of succulent leaves, new vegetative shoots, inflorescences and even fruit stalks.

The body of the nymph, as it grows, becomes thickly coated with a white waxy substance which protects the insect against various contact insecticides, *viz.*, DDT, BHC[1] and resin fish oil soap.[2] Destruction of egg masses by exposing them to the sun during June also does not prove effective.[2] The only successful method known, so far, is to apply sticky bands around the trunk of the tree with a view to create a barrier for the ascending newly-hatched nymphs.[3,4] This method, however, needs frequent applications of the sticky material as it dries out due to exposure. Moreover, dry leaves and grasses get stuck to it and provide necessary passage for the nymphs to crawl up. Besides, the method is quite a costly one as well.

In order to find an easier and cheaper method of control of *Drosicha stebbingi* on mango, the author carried out trials with several insecticides in different strengths and found that 20% Diazenon emulsifiable concentrate in the dilution of 1 : 600 during the last week of March when the nymphs were in the third instar, was most effective. A single spray was capable of making them drop down from the shoots in less than 20 hours. Most of the nymphs were found dead, while others were in a moribund stage. The entire affected region became free from the bugs in 48 hours and those seen adhering to the twigs were also dead. No adverse effect of the insecticide was noticed either on the new growing shoots, inflorescences or on the setting of fruits. Moreover, the insecticide at the same time brought about the complete mortality of mango hoppers, *Idiocerus* spp. and their nymphs.

A detailed account of the control work will appear elsewhere. I am grateful to Dr. L. B. Singh for encouragement.

Govt. Fruit Res. Station, Saharanpur, *March* 28, 1956. S. M. SINGH.

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A RICE STEM-BORER, UNRECORDED IN INDIA, *PROCERAS POLYCHRYSA* MEYR. (PYRALIDÆ : LEPIDOPTERA)

DURING the early part of the 1955-56 paddy cultivation season, caterpillars of *Proceras* (*Diatræa*) *polychrysa* Meyr., were observed attacking paddy plants in the Vellayani lake reclamation fields. *P. polychrysa* was first described by Meyrick[1] who found the caterpillars feeding in stems of rice, maize and *Scirpus gressus* in Malaya. Subsequently, heavy attacks by the pest on rice were recorded there.[2-4] The occurrence of *P. polychrysa* outside Malaya has not so far been recorded and the present record of its occurrence as a stem-borer of paddy in India appears to be the first.

The adult is a slender-built moth, 17-20 mm. in wing expanse, yellowish-brown in colour, with a characteristic row of thick bronzy spots medially and a row of thin bronzy spots submarginally on forewings. The full-grown caterpillar measuring 20-26 mm. × 2-3 mm., is slender, whitish, with head and prothoracic shield black. There are five longitudinal violet stripes, three dorsal which are bold and two lateral which are faint. The young caterpillar bores into the outer leaf-sheaths of paddy plants, making longitudinal tunnels in them. At times mid-ribs of leaves are found tunnelled by the small caterpillars. As the caterpillar grows, it enters the inner stem. The tunnels are filled with yellowish frass which is often seen outside the attacked plants. The attacked plants show dead leaves as well as 'dead hearts'. Most often several caterpillars are found inside a single plant. Pupation takes place inside the tunnel formed by the caterpillar. Pupa is slender, measures 10-12 mm. × 2 mm., and is dirty brown in colour. Emergence of the moth takes place through an opening on the side of the stem previously made by the caterpillar.

The moth was identified at the Commonwealth Institute of Entomology, London. Thanks are

due to Mr. M. C. Cherian, Principal, and Mr. K. V. Joseph, Entomologist, who helped in the preparation of this note.

Entomology Dept., M. R. G. K. Nair.
Agric. College,
Vellayani, Kerala, *January* 8, 1957.

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CLEISTOGAMOUS MUTANT IN *SETARIA ITALICA* BEAUV.

In the genera Setaria, the spikelet has two florets, the lower either staminate or barren while the upper fertile possessing two lodicules, three anthers and a pistil enclosed by a palea and a lemma. In the cultivated species *Setaria italica* Beauv., it is not only barren but is reduced to its valve.[1] Detailed observations made have shown that all the flowers are chasmogamous. A case of complete cleistogamy spotted in *Setaria italica* Beauv., is described below. Occurrence of cleistogamy in graminese has been noted from as early as 1539. Among the cereals it has been recorded in sorghum,[2] oats and rice.[3]

At the Millets Breeding Station, Coimbatore, a cleistogamous mutant was spotted during 1956 in the bulk crop *Setaria italica* Beauv., strain Co. 3. The panicle appeared to be slender and sparse (Fig. 1) and when examined in detail it was found that at the time of anthesis, unlike the normal spikelets there was either partial or non-emergence of the anthers and stigmas. This abnormal phenomenon was traced to the absence of lodicules in the florets. Since many of the flowers were not complete, 30 to 40% setting only was obtained. The seeds also tended to be smaller than those of the normal plant. The seeds were collected and sown in the main season of 1956. The progeny consisting of 12 plants were found to be cleistogamous resembling the mutant in all respects. The cleistogamous mutant differed also from the parent in many characters (Table I).

Fig. 1. Panicle of Mutant and Normal Plants.

Table I

Variation shown by the mutant

Detail	Normal	Mutant
Spikelet:		
1st glume (lower)	¼ of the spikelet	¼ of the spikelet
2nd glume (upper)	¾ „	4/5 „
Lower valve (lemma)	equal to the spikelet	4/5 „
Valvule (Palea)	Absent	Absent
Upper valve lemma	5/6 of the spikelet	4/5 of the spikelet
Valvule (Palea)	¾ „	¾ „
Lodicules	Present (Two)	Absent
Bristle length	1·4 cm.	1·0 cm.
Tillers:		
Primary	4 to 12	28
Secondary	0 to 3	103
Panicles: Total	4 to 15	131
Length of the main panicle	14 to 17 cm.	7·0 cm.

The study of the inheritance of this character is being continued, and it would be interesting to know whether all other characters occurring in the mutant are closely associated with this factor, or have arisen as mutants of other disconnected genes.

The author's thanks are due to Shri B. W. X. Ponniah for his criticism and guidance.

M. Charles Ratnaswamy.
Millets and Pulses Section,
Agric. Res. Institute,
Coimbatore, *December* 16, 1956.

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REVIEWS

Thermodynamics and Statistical Mechanics (*Lectures on Theoretical Physics*), Vol. V. By Arnold Sommerfeld. Edited by F. Bopp and J. Meixner. English translation by J. Kastin. (Academic Press Inc., New York), 1956. Pp. xi + 401. Price $ 7.00.

Sommerfeld occupies a unique place amongst the great masters of theoretical physics of this century. For lucidity of expression and perspicacity of treatment, he has few rivals. He always places the greatest stress on physical insight, and the mathematics used is simple and appropriate, and is not allowed to becloud the physics under discussion. Six volumes in the series have so far appeared: *Mechanics* (1952); *Mechanics of Deformable Bodies* (1950); *Electrodynamics* (1952); *Optics* (1954); *Thermodynamics and Statistical Mechanics* (1956); *Partial Differential Equations in Physics* (1949).

It is a matter of extreme regret that Sommerfeld did not live to complete his series on theoretical physics. He died (due to a road accident) while he was still working on the volume under review. Chapter V of the book has been written by the Editors. (The original German edition appeared by the end of 1952.)

The book contains five chapters entitled: (i) Thermodynamics: General Considerations; (ii) The Application of Thermodynamics to Special System; (iii) The Elementary Kinetic Theory of Gases; (iv) General Statistical Mechanics: Combinatorial Method; and (v) Outline of an Exact Kinetic Theory of Gases. At the end of the book, about ten pages of problems and hints for solution are provided. There is a reasonably complete index.

Chapter I deals with the laws of thermodynamics, thermodynamic relations and potentials, Joule Thomson Effect, and Properties of Van der Waals Equations. The chapter begins with the zeroth law (existence of temperature) and concludes with an excellent treatment of the Nernst heat theorem and the unattainability of absolute zero of temperature. It seems a little unfortunate to the reviewer that the concept of quantity of heat is introduced 'intuitively' rather than 'logically'. A brief description of Carathéodory's proof of the *Second Law* is also given. There is an interesting and very instructive sub-section on the relative rank of energy and entropy. It is largely based on Robert Emden's note to *Nature* (1938) which does not appear to be as widely known as it should be. Emden writes: "I fetch a bottle of claret from the cold cellar and put it to be tempered in the warm room. It becomes warmer but the increased energy content is not borrowed from the air of the room but is brought in from outside."

Chapter II deals with the applications of thermodynamics to gaseous mixtures and dilute solutions, phase equilibria, galvanic cells and backbody radiation. There is a section on magnetic effects. The last section deals with the thermodynamics of non-equilibrium processes. Onsager's reciprocal relations are described, and the limitations of the theory of irreversible processes are also discussed.

Chapter III deals with the properties of Maxwellian gas (classical gas) and gives an elementary account of the theory of transport phenomena. Chapter IV gives an account of Boltzmann's Combinatorial method in statistical thermodynamics. The method of the most probable state and also the Darwin-Fowler's method of saddle point integration are given. The chapter also discusses the theory of specific heat of gases and solids. A brief account is given of the Bose-Einstein and Fermic-Dirac statistics with an excellent introduction to the electron theory of metals. There is a very interesting section on the theory of fluctuations.

Chapter V gives an outline of an exact kinetic theory of gases. Starting from Maxwell-Boltzmann's collision equation, we pass on to the H-theorems and then follow the fundamental equations of fluid dynamics. The last section is concerned with conductivity and Wiedemann-Franz Law.

All in all this is a splendid book. In fact, one could hardly think of a more lucid and stimulating introduction to thermodynamics and statistical mechanics than what is provided here. There can be no doubt that the book would be found extremely useful and instructive for the B.Sc. (Hons.) and post-graduate classes, and also for those who intend to specialise in this subject.

D. S. KOTHARI.

Numerical Analysis. By Z. Kopal. (Chapman & Hall, London), 1955. Pp. xiv + 556. Price 63 *sh.*

This is a very comprehensive book on the subject of numerical analysis. The author, now

Professor of Astronomy at Manchester, had been lecturing on this subject at the M.I.T. and the book is the outcome of these lectures. It presents in a very clear manner not only the theoretical aspects, but contains a large number of numerical examples, besides a number of problems appended to each chapter. There is also a bibliographical note at the end of each chapter, in which are given references to the original literature, as well as suggestions for further reading.

The volume starts with an introductory historical survey dating from the origin of the concept of number in the ancient times and contains seven other chapters dealing with polynomial interpolation, numerical differentiation, integration of ordinary differential equations, boundary valve problems, quadrature formulæ and numerical solution of integral and integro-differential equations. A number of appendices containing tables of data for interpolation and other processes are added at the end.

Unfortunately, the book does not deal with solution of linear simultaneous equations, computation of determinants and numerical methods of harmonic analysis and Fourier synthesis which are of great interest to the physicist, although an appendix gives a list of references on the first topic. This is probably because the emphasis is on "The Application of Numerical Techniques to Problems of Infinitesimal Calculus in Single Variable", as stated in the subtitle to the book.

The volume will be found useful by all classes of readers, from the under-graduate beginners who wish to learn the subject to the researcher in applied mathematics, who would find it an excellent reference book.

Physical Techniques in Biological Research, Vol. I. (*Optical Techniques.*) Edited by G. Oster and A. W. Pollister. (Academic Press Inc., New York), 1955. Pp. xi + 5. Price not given.

During recent years, the line of demarcation between physical and biological sciences has tended to become more and more indistinct. Physicists and chemists have attempted to use their techniques for the study of biological systems and biologists themselves have felt the need for accurate physico-chemical studies for a complete understanding of their subject. The appearance of this series of volumes devoted to the applications of physical methods in biology is therefore particularly welcome.

Volume I deals with optical techniques, including electron microscopy. The topics dealt with are photochemistry and luminescence, visible, ultraviolet and infrared spectroscopy; light scattering and birefringence; the microscope, including phase contrast methods; electron microscopy. Each article is written by a specialist, particularly familiar with that subject, a feature which has become very common in recent books. The articles are all written with an emphasis on the needs of the biologist rather than that of the physicist. Aspects of instrumentation are particularly well stressed and although the main steps in the interpretation of the data are pointed out, the physicist is left somewhat unsatisfied with the theoretical parts. The results of the theories are clearly and analytically discussed, but it would have been worthwhile to have considered briefly also the basic assumptions in the theories. But for this minor omission, all the articles give excellent accounts of the present state of knowledge in each field and there is no doubt that they would help in increasing the rate at which these techniques are applied in biological problems.

The volume can be warmly recommended to all interested in biophysics. The appearance of Volumes II and III dealing with physical chemical techniques and cells and tissues respectively would be looked forward to with great interest.

G. N. RAMACHANDRAN.

Chemistry of Carbon Compounds, Vol. III. (*Aromatic Compounds*), Part B. Edited by E. H. Rood. (Elsevier Publishing Co.), 1956. Pp. 687-1670. Price £ 8 10. *sh.*

This is a further addition to the important series dealing with organic chemistry. Volume III is allotted for aromatic compounds having homocyclic rings. In Part A was given a description of the simpler derivatives of benzene. More complex types are dealt with in Part B which also completes the account of benzene derivatives. A large number of well-known and experienced organic chemists have written the chapters. Excellent accounts are found on many topics of current interest such as quinones including naphthaquinones and athraquinones, azulenes, isocoumarins, tannins and depsides. Owing to restrictions of space, many of them are dealt with rather briefly, but the literature cited enables the reader to obtain detailed information. The chapter on monocyclic quasi-aromatic compounds is particularly interesting. It gives a good description

of tropolones including tropylium salts, and derivatives of cyclopentadiene including a detailed account of the highly interesting iron compound, ferrocene.

The later portions of the book are devoted to aromatic compounds containing a number of benzene rings and belonging to various types such as anthracene, phenanthrene, fluorene, acenaphthene and polycyclic compounds. Though there are occasional errors of minor nature that have escaped notice, the treatment of the various topics is uniformly good; the literature references are very useful and the index is extensive. The volume constitutes therefore another welcome addition to the library of both the teacher and the student of organic chemistry.

T. R. S.

Enzymes and Metabolism. (Elsevier Publishing Company, New York), 1956. Pp. 287. Price 47 *sh.* 6 d.

The book is a collection of papers dedicated to Carl F. and Gerty T. Cori on the occasion of their 60th birthday, the original edition of the book having appeared as an issue of *Biochemica et Biophysica Acta*, Volume 20, No. 1, 1956. At least one of the authors of every paper was either Coris' former student or associated with the Cori Laboratory. Their scholarly contributions reflect in a large measure the high standards of excellence instilled in the authors by their teacher and/or associate. The introductory article about the life and achievements of the Coris, written by B. A. Houssay who shared with them the Nobel Award for physiology and medicine in 1947, is a thrilling story which bears evidence of their rare imagination and experimental rigour throughout an extraordinarily busy life lived in conformity to the highest scientific traditions.

There are thirty-two papers in this volume, most of them pertaining to several aspects of carbohydrate metabolism to the progressive understanding of which the contributions of the Coris proved invaluable. The articles on the molecular weights of some crystalline enzymes from muscle and yeast, on galactosemina as a congenital defect in a nucleotide transferase and on the mechanism of antibody-antigen reaction, to mention only a few, serve as pointers to indicate the vast progress made in the understanding of enzymatic processes during this decade and the exciting truths that remain to be unravelled in the future. The editors have done a nice job in the selection of articles and their arrangement to justify the title. The inclusion of articles such as 'the biosynthesis of DNA in the bone marrow and neoplastic cells', the 'enzymatic synthesis of polynucleotides', 'formation of purines and RNA in Baker's yeast', etc., is to be appreciated since some of them demonstrate the interlinking of carbohydrate, amino acid and nucleic acid metabolism.

This method of bringing forth volumes dedicated to pioneers in science on occasions like this is indeed worth emulating. This handsomely bound volume is well printed on fine paper, and the photographs and figures are especially well reproduced.

K. V. Giri.

Some Protozoal Diseases of Man and Animals, Anaplasmosis, Babessiosis and Toxoplasmosis. By C. Cole and 19 others. (*Annals of the New York Academy of Sciences*), 1956. Vol. 64, Art. 2. Pp. 25-277. Price $ 3.5.

The incidence and epidemiological aspects of many protozoan diseases affecting man and animals still need elucidation. Research carried out in certain parts of U.S.A. and Europe on the prevalence of Anaplasmosis, Babessiosis and Toxoplasmosis and presented in this volume, stress the need for an investigation on a global scale. These should be studied by veterinarians and public health authorities interested in the preservation of the cattle wealth of the country and adoption of public health measures to eradicate the spread of the disease to human population.

Anaplasmosis is an infectious disease of the cattle caused by *Anaplasma marginale*. Field surveys have shown the prevalence of the disease in nearly 45% of the cattle in certain areas of U.S.A. The essential features of this disease are presented in Part I. The need to diagnose the disease even in the absence of the parasite in the blood, the status of complement fixation test as regards its accuracy, and specificity, the still doubtful probable relative role of the flies, mosquitoes and ticks as natural transmitting agents are presented in a concise manner. The absence of a suitable screening test for a study of chemotherapeutic drugs has handicapped large-scale trials. Oxytetracycline and chlorotetracycline are mentioned as the only drugs exhibiting slight suppressive action.

A discussion on the piroplasma of domestic animals and their worldwide incidence constitutes the second part. An exhaustive survey of the literature pertaining to the classification, transmission and biology of piroplasma and the complexities involved in the immunological phenomenon is a notable feature of this section. The lists given will be of value to veteri-

narians engaged in the control of tick-borne disease and to zoologists occupied in systematic classification. The biological approach is an interesting feature for chemotherapeutic research. The atypical manifestation as exemplified by the ocular, respiratory, digestive, nervous and rheumatic symptoms indicate the difficulties to be encountered in the diagnosis in the absence of the demonstration of the parasite.

The third and the last part deals with Toxoplasmosis. The association of this protozoal infection with human disease has led to extensive research resulting in the recognition of its widespread prevalence both in the human and in animals. The propagation and morphology of the protozoan including electron microscopy studies, biological aspects dealing with epidemiology, propagation by tissue culture techniques, host range among mammals, modes of transmission, course of infection, diagnostic procedures, congenital human toxoplasmosis and dynamics of pathogenesis have been dealt in a comprehensive manner. The discussions on the organisms resembling toxoplasma, on the nomenclature of *Besnoitia besnoiti* and transmission of *B. jellisoni* by ingestion are highly informative.

M. SIRSI.

Elements of Geology (Third Edition). By E. de C. Clarke, R. T. Prider and C. Teichert. (Revised by R. T. Prider.) (The Western Australia Press, Nedlands, Western Australia), 1955. Price 40 *sh.*

This book deals with the general principles of geology in three sections, with illustrations from Western Australia. In the introductory section are given definitions, general characters of the earth, the divisions of geology and its relation to the other sciences. Then follow an account of the work of pioneer geologists of Western Australia and the outline of the growth of knowledge of the geology of the country. In the section on physical geology, an account is given of the general constitution of the lithosphere rocks and minerals, and a detailed account of igneous rocks. Then follows an account of atmosphere-weathering and the constructive and destructive work of wind. An examination of the action of rivers, river development, underground water, ocean and lakes, glaciers and icebergs, and the action of organisms are all dealt with in detail. A chapter each is devoted to sedimentary rocks, earth movements and metamorphism. The one on earth movements also includes an account of folding, jointing, faulting, and diastrophism, while the chapter on metamorphism also deals with such modern concepts as granitization. In the section on historical geology, the several systems are described with an account of their characteristic rock formations and fossils.

The various chapters are copiously illustrated with examples from Western Australia, as the book is primarily intended for students of Western Australia. But every chapter contains first statements of general principles of geology, and these are so lucidly and concisely stated that every student of geology in any country will find the book an excellent introduction to the subject of geology.

P. R. J.

Books Received

Aureomycin (Chlortetracycline). Antibiotics Monographs No. 7. By Mark H. Lepper. (Published by Medical Encyclopædia, Inc., New York), 1956. Pp. 156. Price 5.00.

Transactions of the Symposium on Partial Differential Equations held at the University of California at Berkeley, June 20-July 1, 1955. Edited by A. Aronszajn, A. Douglis and C. B. Morrey, Jr. (Interscience Pub.), 1956. Pp. vi + 334. Price $ 6.50.

Organic Analysis, Vol. III. Edited by John Mitchell, Jr., I. M. Kolthoff, E. S. Proskaur and A. Weissberger. (Interscience Pub.), 1956. Pp. viii + 546. Price $ 11.50.

Sperm Whales of the Azores. By Robert Clarke. (*Discovery Reports,* Vol. 28. Pp. 237-298.) (Cambridge University Press), 1956. Price 27 *sh.* 6 *d.* net.

Sir Richard Gregory—His Life and Work. By W. H. G. Armitage. (Macmillan & Co.), 1957. Pp. 241. Price 21 *sh.*

The Amphibia of Ceylon. By P. Kirtisinghe. (Published by the Author, Dept. of Zoology, University of Ceylon, 2, Charles Circus, Colombo 3), 1957. Pp. xiii + 112. Price not given.

PROCEEDINGS OF THE SIXTH ANNUAL ROCHESTER CONFERENCE, 1956*

THE Rochester Conference is an annual stock-taking of the progress in high energy nuclear physics during the current year. The Conference is open only to a relatively small but representative group of active workers from laboratories throughout the world, for an informal and complete discussion of the problems in experimental and theoretical high energy nuclear physics. Hence the publication of the proceedings of the Conference will be welcomed by all research workers who had not the opportunity to attend the Conference but who wish to acquaint themselves with the progress of the subject.

The Sixth Conference in April 1956 consisted of nine sessions which can be broadly grouped under four heads: (i) Classical pion physics and pion-nucleon and nucleon-nucleon interactions; (ii) New particles, experimental work and theoretical interpretation; (iii) General theoretical session on meson physics; and (iv) Miscellaneous topics like mesonic atoms. Each session was preceded by an introductory survey and followed by discussions.

Pion Physics.—The introductory talk was given by Goldberger who first dealt with one of the most important developments of the past year, the reinvestigation of the cut-off meson theory on the basis of a formulation of scattering problems in field theory given by Low. He later introduced the extended application of "Dispersion" relations to the pion-nucleon system. By dispersion relations is meant things analogous to the famous Kramers-Kronig formula which relates the real part of the coherent forward light scattering amplitude to an integral over the total photon cross-section. The theory is shown to be a strict consequence of microscopic causality as expressed in the framework of field theory by the demand that the commutators of the two vector potentials taken at space-like points shall vanish. The extension of these results to the cases of non-vanishing rest-mass and non-forward scattering were presented by Goldberger.

The papers on classical pion physics and nucleon-nucleon scattering below 500 mev. essentially dealt with phase shift analysis. Above 500 mev., the data on pion-nucleon and nucleon interactions were presented.

New Particles.—One of the leading experimental achievements of current year was the production of antiprotons by Segre's group in California. The cosmic ray evidence on anti-nucleon production was discussed by Rossi and Amaldi.

The introductory survey on the properties of heavy mesons and hyperons was given by Leprince-Ringuet. Gottstein's summary on τ-mesons was followed by a spate of experimental data relating to the new particles from European and American laboratories.

By far the most interesting discussions on the theoretical work related to the interpretation of new particles. It is well known that the first and major puzzle was to reconcile the copious production of the new particles with their slow and rather peculiar decay. This problem has reached a temporary kind of solution in the theory of strangeness first introduced by Nishijima, Gellman and Pais in 1954. "We are at a stage corresponding to the finding of the duplexity of atomic spectra but not yet at the point of the discovery of electron spin and certainly not at the stage of Dirac's theory of the electron."

Yang's introductory talk on the theoretical interpretation of these new particles was a masterly exposition on a subject in which a clear picture does not exist. The firm establishment of the strangeness quantum number through experiments during the past year was encouraging to both the theorist and the experimenter alike. During the discussion, a very important question was raised on the θ-τ degeneracy by Feynman: "Does nature have a way of defining right- or left-handedness uniquely?" The answer seems to have been given by Yang and Low in a recent paper which may perhaps be discussed in the coming Conference.

As regards the classification of the fundamental particles some interesting Russian work was presented by Markov. Similar attempts at classification were made by Sakata in Japan.

General Theoretical Session.—The introductory talk by Kallen on possible inconsistency of field theories was followed by a presentation of the Russian work by Silin on Tamm-Dancoff calculations, Peierls on the application of the functional integral method and by a few others on the work of Chew and Low.

Miscellaneous Topics.—The papers dealt with mesonic atoms, electron-nucleon and photon-nucleon scattering, z-dependence of 'Brem-

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* *High Energy Nuclear Physics, Proceedings of the Sixth Annual Rochester Conference, 3-7 April 1956*, Edited by J. Ballam V. L. Fitch, T. Fulton, K. Huang, R. R. Rau and S. B. Treiman (Interscience, New York), 1956. Price $3.75, Pp. 54.

strahlung' at high energy, and cosmic ray data on high energy cascades.

The Proceedings of the Conference may leave an impression on the reader that the initiative in high energy physics has passed from cosmic ray groups to the workers on high energy accelerators. This is as should be expected, since the accelerators are sources of copious production of high energy particles under controllable conditions. The cosmic ray workers can draw consolation from the fact that energies beyond 25 Bev. are still within their domain.

The pace of experimental work to-day and the consequent pressure on the theoretician to speculate may make any researcher wonder whether it is possible to acquaint himself with the progress in the whole domain of physics. Yet he can share the excitement by going through the Proceedings of the Rochester Conference.

A. RAMAKRISHNAN.

SCIENCE NOTES AND NEWS

Chromosome Number of *Rauvolfia serpentina* Benth.

Shri V. Chandra, Botany Laboratory, National Botanic Gardens, Lucknow, observes: A perusal of literature shows that so far no report has been made of the chromosome number of *Rauvolfia serpentina* Benth. The chromosome count based on smeared material indicated $2n = 24$ and $n = 12$. Thanks are due to Prof. K. N. Kaul, Director, National Botanic Gardens, for encouragement and guidance.

Solar Deflexion of Light

The deflexion of starlight by the gravitational field of the sun forms one of the three well-known tests of the theory of relativity. Einstein's theory predicts that a ray of light passing close to the sun will be deflected through an angle twice that predicted by Newtonian mechanics. While the relativistic effect has been discussed in print on many occasions, it is rare to find a text-book which treats the problem by means of Newtonian mechanics. Teachers and students will therefore be glad to have such a treatment available, and Dr. M. Davidson (*J. Brit. Astro. Assoc.*, 1956, 66, 268) has provided one, deriving the result from first principles without even the use of the usual formulæ of dynamical astronomy; the use of the latter formulæ would provide a still shorter derivation.

Gases as Lubricants

The use of gases as lubricants is helping to solve one of the major problems of atomic energy establishments. The radiations emitted in various atomic energy operations have no effect on the gas bearings, whereas organic lubricants deteriorate seriously in radiation fields.

A machine for pumping radioactive liquid bismuth at 400° C. utilizes an inert gas, helium or argon, for lubrication. Another machine is used to circulate carbon dioxide as coolant gas in nuclear reactors. The speed range of this machine is 2,000-13,000 r.p.m. and the rotating parts are lubricated by a suitable inert gas. Gas-lubricated equipment also offers secondary benefits such as independence of auxiliary equipment, very long life without attention and quietness of operation. Their low heat losses and the ease of cooling on account of their large surface area as compared to liquid types offer particular advantage for high speed machines. In addition to atomic energy purposes, gas lubricants are used in gas handling machinery in chemical plant, in gas turbine and compressors and in applications where cleanliness is important.—(*Chem. Tr. J.*, 1956, 139, 629.)

World Health Day, April 7, 1957

On April 7, 1948, the Constitution of the World Health Organization officially came into force. Each anniversary is now observed as World Health Day and is used by national and local health authorities to interest people in health needs and to stimulate their co-operation in health action. A definite theme for the observance is selected every year to focus public attention on particular aspects of health.

The theme chosen for World Health Day, 1957, is 'Food and Health' and an effort is being made by WHO and FAO to interest public opinion everywhere in the various aspects of the relationship between food supplies, food habits and the health situation of a community.

Indian Science Congress, 1958

Prof. M. S. Thacker, Director, Council of Scientific and Industrial Research, New Delhi, has been elected General President of the Forty-Fifth Session of the Indian Science Congress to be held at Madras in January 1958.

The following are the Presidents of the various sections: *Mathematics*: Dr. B. S. Madhava Rao, Bangalore; *Statistics*: Dr. K. Kishen, Lucknow; *Physics*: Sri. S. L. Malurkar, Bombay; *Chemistry*: Dr. S. Ghosh, Allahabad; *Botany*: Prof. T. S. Sadasivan, Madras; *Zoology and Entomology*: Dr. P. Bhattacharya, Izatnagar; *Anthropology*: Dr. G. M. Kurulkar, Bombay; *Medicine and Veterinary Sciences*: Dr. A. K. Bose, Calcutta; *Agricultural Sciences*: Dr. P. N. Bhaduri, Calcutta; *Psychology and Educational Sciences*: Dr. A. K. P. Sinha, Patna; *Engineering and Metallurgy*: Prof. C. S. Ghosh, Bangalore; *Geology and Geography*: Dr. A. G. Jhingram, Lucknow.

National Institute of Sciences of India

At the Twenty-Second Anniversary General Meeting of the National Institute of Sciences of India held recently, the following officers were elected to the Council for the year 1957: *President*: Prof. P. C. Mahalanobis (Delhi); *Vice-Presidents*: Prof. S. P. Agharkar (Poona), Prof. D. S. Kothari (Delhi); *Foreign Secretary*: Dr. B. Mukerji (Lucknow); *Secretaries*: Sri. S. Basu (Delhi), Prof. P. Maheshwari (Delhi); *Editor of Publications*: Prof. R. C. Majumdar (Delhi).

National Dyestuffs

The Government of India has decided that the National Industrial Development Corporation should undertake the manufacture of the primary intermediates required for the production of dyestuffs as part of the programme for the development of the dyestuffs industry. Reports have also been received by the Government from the German Bayer organisation and from Imperial Chemical Industries, Ltd., in England, touching matters concerned with the Second Five-Year Plan requirement for raising dyestuffs production from 6·6 million lb. to 27 million lb. per year.

Uranium Production in U.S.A.

The Atomic Energy Commission, U.S.A., has disclosed for the first time statistics concerning uranium ore reserves and uranium mining and milling operation. The uranium ore reserves still in the ground on 1st November 1956, were estimated in millions of tons as follows: New Mexico, 41; Utah, 7·5; Colorado, 4·1; Arizona, 2·6; Wyoming, 2·3; Washington, 1·5; and others, 1. The total is 60 million tons.

The uranium ore mined during the period from July to December 1955, was 840,000 dry tons; from January to June 1956, 1·34 million dry tons; and from July to December 1956, 1·66 million dry tons.

At present, 12 uranium mills are in operation in the United States. All are privately-owned with the exception of one AEC-owned plant. The total private investment is established at $ 50 million, with a total daily capacity of 8,960 tons. Eight more mills, representing an investment of about $ 35 million and a rated daily capacity of 4,025 tons, are scheduled for completion in 1957 or early 1958.

Synthesis of Rubber by Micro-Organisms

A paper at the AAAS Meeting in New York in December 1956 described some investigations sponsored by the Office of Naval Research, on the synthesis of rubber by fungi of the genus, *Lactaria*. Over 20 species were isolated in pure culture, but some would not grow on the usual media. A source of organic nitrogen was required by all species to obtain good growth.

Further experiments with the five fastest growing species showed that a two-week culture period on liquid media at temperatures of 22-26° C. gave sufficient cell material for rubber extractions. The mycelia were frozen and thawed to rupture the cells and extracted with alcohol, acetone and benzene, in an atmosphere of nitrogen. The benzene extracts of all five species yielded compounds, precipitated by methanol, which ranged from 'sticky' liquids to elastic rubbery solids. Infra-red spectra showed these polymers to be more highly oxygenated than those extracted from spore-bearing structures.

Award of Research Degree

The Andhra University has awarded the D.Sc. Degree in Chemistry to Sri. M. Suryanarayana for his thesis entitled "Studies in Analytical Chemistry of Molybdenum".

299-57. Printed at The Bangalore Press, Bangalore City, by C. Vasudeva Rao, Superintendent and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.
Editor: Prof. G. N. Ramachandran, A. C. College of Technology, Madras 25.

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